

I. Title of Application

Application for a Permit for Scientific Research and to enhance the survival or recovery of a stock under the Marine Mammal Protection Act and the Endangered Species Act

II. Date of Application

8 March 2003

III. Applicant and Personnel

A. Applicant:

Peter L. Tyack

MS #34

Biology Department

Woods Hole Oceanographic Institution

Woods Hole MA 02543

Ph: 508-289-2818

Fax: 508-457-2134

ptyack@whoi.edu

Principal Investigator:

Peter L. Tyack

Senior Scientist

Walter A and Hope Noyes Smith Chair

Co-Investigators:

Robin Baird, Nicoletta Biassoni, Alessandro Bocconcelli, J. Fabrizio Borsani, Carol Carson, Jonathan Gordon, Mark Johnson, Patrick Miller, Michael Moore, Douglas Nowacek, Simone Panigada, Susan Parks, Michela Podestá, Maria Elena Quero, Kenneth Shorter, Natacha Aguilar de Soto, Peter Stein, Peter Teglberg Madsen, Valeria Teloni,

B. Qualifications and Experience

For the following Co-Investigators please use qualifications and experience information listed under original application for permit no. 981-1578:

Robin Baird, Nicoletta Biassoni, Alessandro Bocconcelli, J. Fabrizio Borsani, Jonathan Gordon, Mark Johnson, Michael Moore, Douglas Nowacek, Simone Panigada,

For the following Co-Investigator please use qualifications and experience information listed under first application for amendment to permit no. 981-1578:

Patrick Miller

For the following Co-Investigators please use qualifications and experience information listed under third application for amendment to permit no. 981-1578:

Carol Carson, Natacha Aguilar de Soto, Susan Parks, Maria Elena Quero, Peter Stein, Valeria Teloni

PETER LLOYD TYACK

Senior Scientist (with tenure)

Walter A. and Hope Noyes Chair in Oceanography

Biology Department

Woods Hole Oceanographic Institution

Woods Hole, Massachusetts 02543 USA

**EDUCATION**A.B., *summa cum laude* in Biology, Harvard College, 1976.

Ph.D., in Animal Behavior, Rockefeller University, 1982, Donald R. Griffin, advisor.

EMPLOYMENT

1971-1972:	Research Assistant	Alza Co
1974-1975:	Research Associate	New York Zoological Society
1976:	Staff Biologist	Oregon Public Utilities Commission
1977-1981:	Research Associate	New York Zoological Society
1977-1982:	Graduate Fellow	Rockefeller University
1982-1983:	Postdoctoral Scholar	Woods Hole Oceanographic Institution
1983-1985:	Guest Investigator	Woods Hole Oceanographic Institution
1985-1989:	Assistant Scientist	Woods Hole Oceanographic Institution
1989-1999:	Associate Scientist	Woods Hole Oceanographic Institution
1994-1995:	Fellow	Center for Advanced Study in the Behavioral Sciences, Stanford CA
1999-:	Senior Scientist	Woods Hole Oceanographic Institution
2001-	Walter A. and Hope Noyes Chair in Oceanography	Woods Hole Oceanographic Institution

MEMBERSHIPS

Member, Committee of Scientific Advisors on Marine Mammals, Marine Mammal Commission (2000-2003)

Committee to Review Results of ATOC's Marine Mammal Research Program. Ocean Studies Board, National Research Council (1996-2000)

Committee on Low Frequency Sound and Marine Mammals, Ocean Studies Board, National Research Council (1992-1994)

Trustee, Center for Coastal Studies (1996-1999)

Member, Scientific Advisory Board, New England Aquarium (1992-1996)

Advisory Board for Marine Mammal Research Program, ATOC.

Member; Acoustical Society of America, Animal Behavior Society; A.A.A.S., Sigma Xi

Charter Member, Society for Marine Mammalogy

Associate, Behavioral and Brain Sciences.

Fellow, Center for Climate and Ocean Research (CICOR)

Fellow, Acoustical Society of America

Associate Editor, Marine Mammal Science, Encyclopedia of Ocean Sciences, IEEE

Journal of Oceanic Engineering

RESEARCH INTERESTS

- Social behavior and acoustic communication in cetaceans.
- Vocal learning and mimicry in the natural communication systems of cetaceans.
- Individually distinctive signature signals, vocal learning, and mimicry in the bottlenose dolphin and the sperm whale.
- Acoustic structure and social functions of the songs of baleen whales.
- Responses of cetaceans to manmade noise.
- Playback to cetaceans of their own and conspecific vocalizations.
- Development of methods to identify which cetacean produces a sound within a social group.

BOOKS

- 2003 de Waal, F. and P.L. Tyack, editors. *Animal Social Complexity: Intelligence, Culture, and Individualized Societies*. Harvard University Press
- 2000 Mann, J., Connor, R., Tyack, P.L., and H. Whitehead, editors. *Cetacean Societies: field studies of whales and dolphins*. Chicago: University of Chicago Press.
- 2000 Popper, A.N., DeFerrari, H.A., Dolphin, W.F., Edds-Walton, P.L., Greve, G.M., McFadden, D., Rhines, P.B., Ridgway, S.H., Seyfarth, R.M., Smith, S.L., and P.L. Tyack. *Marine mammals and low-frequency sound*. (NRC report) Washington, D.C.: National Academy Press.
- 1994 Green, D.M., DeFerrari, H.A., McFadden, D., Pearse, J.S., Popper, A.N., Richardson, W.J., Ridgway, S.H., and P.L. Tyack. *Low-frequency sound and marine mammals: current knowledge and research needs*. (NRC report) Washington, D.C.: National Academy Press.

PUBLICATIONS

- 2003 Zimmer W. M.X., M. P. Johnson, A. D'Amico, P. L. Tyack. Combining data from a multi-sensor tag and passive Sonar to determine the diving behavior of a sperm whale (*Physeter macrocephalus*). IEEE Journal of Oceanic Engineering. 28:13-28
- 2003 Johnson M. and P. L. Tyack A Digital Acoustic Recording Tag for Measuring the Response of Wild Marine Mammals to Sound. IEEE Journal of Oceanic Engineering. 28:3-12.
- In revision Biassoni, N., P. Miller, and P. L. Tyack. Humpback whales, *Megaptera novaeangliae*, alter their songs to compensate for manmade noise. Journal of Comparative Psychology.
- In revision Miller, P., Shapiro, A., Solow, A., and P. L. Tyack. Matched vocal exchanges of shared stereotyped calls in free-ranging killer whales, *Orcinus orca*. Animal Behavior.

- 2002 Baird R. W., J. F. Borsani, M. B. Hanson and P. L. Tyack. Diving and night-time behaviour of long-finned pilot whales in the Ligurian Sea. *Marine Ecology Progress Series* 237:301-305
- 2002 Miksis, J.L., Tyack, P.L. and J. R. Buck. Captive dolphins, *Tursiops truncatus*, develop signature whistles that match acoustic features of human-made sounds. *Journal of the Acoustical Society of America*, 112:728-739.
- 2002 Tyack, P.L. and E.H. Miller. Vocal anatomy, acoustic communication, and echolocation in marine mammals. In: *Marine mammal biology: an evolutionary approach*. (A.R. Hoelzel, ed), Blackwell Scientific, Oxford, England, pp. 142-184.
- 2002 Tyack, P.L. Behavior, overview. *Encyclopedia of Marine mammals*. (W. Perrin, B. Würsig, and J.G.M. Thewissen, eds) Academic Press, San Diego, pp 87-94.
- 2002 Tyack P.L. Mimicry. *Encyclopedia of Marine mammals*. (W. Perrin, B. Würsig, and J.G.M. Thewissen, eds) Academic Press, San Diego, pp. 748-750.
- 2001 Matthews J.N., S. Brown, D. Gillespie, M. Johnson, R. McLanaghan, A. Moscrop, D. Nowacek, R. Leaper, T. Lewis and P. Tyack.. Vocalisation rates of the North Atlantic right whale (*Eubalaena glacialis*). *J. Cetacean Res. Manage.* 3(3):271-282.
- 2001 Tyack, P. L. New light on the singing whale - what fresh research techniques have shown about the humpback. In *The New Encyclopedia of Mammals*, pages 268-269, Editor D.W. Macdonald, Oxford University Press.
- 2001 Miksis J. L., M. D. Grund, D. P. Nowacek, A. R. Solow, R. C. Connor and P.L. Tyack. Cardiac Responses to Acoustic Playback Experiments in the Captive Bottlenose Dolphin, *Tursiops truncatus*. *Journal of Comparative Psychology* 115:227-232.
- 2001 Gordon J. and P.L. Tyack. Acoustic techniques for studying cetaceans. In: *Marine mammals: biology and conservation*. (P.G.H. Evans and T. Raga, eds), Plenum Press, London, pp. 293-324.
- 2001 Gordon J. and P.L. Tyack. Sounds and Cetaceans. In: *Marine mammals: biology and conservation*. (P.G.H. Evans and T. Raga, eds), Plenum Press, London, pp. 139-196.
- 2001 Tyack P.L. Bioacoustics. *Encyclopedia of Ocean Science*. (Steele J. ed.) Academic Press, London, pp. 295-302.
- 2001 Tyack P.L. Marine Mammal Overview. *Encyclopedia of Ocean Science*. (Steele J. ed.) Academic Press, London, pp. 1611-1621.
- 2001 Tyack P.L. Social Organization and Communication. *Encyclopedia of Ocean Science*. (Steele J. ed.) Academic Press, London, pp. 1621-1628.

- 2001 Nowacek, D. P., Johnson, M. P., Tyack, P. L., Shorter, K., McLellan, W. A., and D. A. Pabst. Buoyant balaenids: the ups and downs of buoyancy in right whales. *Proceedings of the Royal Society B* 268:1-6
- 2000 Nowacek D., R. S. Wells, and P. L. Tyack. A platform for continuous behavioral and acoustic observations of free-ranging marine mammals: overhead video combined with underwater audio. *Marine Mammal Science* 17:191-199.
- 2000 Miller, P.J.O., N. Biassoni, A. Samuels, and P.L. Tyack. Whale songs lengthen in response to sonar. *Nature* 405:903
- 2000 Tyack, P.L. Dolphins whistle a signature tune. *Science* 289:1310-1311.
- 2000 Buck, J.R., H.B. Morgenbesser, and P.L. Tyack. Synthesis and modification of the whistles of the bottlenose dolphin, *Tursiops truncatus*. *J. Acoust. Soc. Am.* 108:407
- 2000 Samuels, A. and P.L. Tyack. Flukeprints: a history of studying cetacean societies. In: *Cetacean societies: field studies of dolphins and whales*. (J. Mann, R. Connor, Tyack, P.L., and H. Whitehead, eds), University of Chicago Press, Chicago, pp. 9-44.
- 2000 Whitehead, H., Christal, J. and P.L. Tyack. Studying cetacean social structure in time and space: innovative techniques. In: *Cetacean societies: field studies of dolphins and whales*. (J. Mann, R. Connor, Tyack, P.L., and H. Whitehead, eds), University of Chicago Press, Chicago, pp. 65-87.
- 2000 Tyack, P.L. Functional aspects of cetacean communication. In: *Cetacean societies: field studies of dolphins and whales*. (J. Mann, R. Connor, Tyack, P.L., and H. Whitehead, eds), University of Chicago Press, Chicago, pp. 270-307.
- 2000 Whitehead, H., Reeves, R.R., and P.L. Tyack. Science and conservation, protection, and management of cetaceans. In: *Cetacean societies: field studies of dolphins and whales*. (J. Mann, R. Connor, Tyack, P.L., and H. Whitehead, eds), University of Chicago Press, Chicago, pp. 308-332.
- 2000 Tyack, P.L. and C.W. Clark. Communication and acoustic behavior of dolphins and whales. In: *Hearing by whales and dolphins*. (W. Au, A.S. Popper, and R. Fay, eds), Springer Handbook of Auditory Research Series, Springer Verlag, New York, pp. 156-224.
- 1999 Tyack, P.L. Communication and Cognition. In: Volume 1, *Biology of Marine Mammals* (J.E. Reynolds III and J.R. Twiss Jr. eds), Smithsonian Press, Washington DC, pp. 287-323.
- 1999 Sayigh, L.S., P.L. Tyack, R.S. Wells, A. Solow, M.D. Scott, and A.B. Irvine. Individual recognition in wild bottlenose dolphins: a field test using playback experiments. *Animal Behavior* 57:41-50.

- 1998 Burgess, W.C., P.L. Tyack, B.J. LeBoeuf, and D.P. Costa. A programmable acoustic recording tag and first results from free-ranging northern elephant seals. *Deep-Sea Research* 45:1327-1351.
- 1998 Miller P. and P.L. Tyack. A small towed beamforming array to identify vocalizing resident killer whales (*Orcinus orca*) concurrent with focal behavioral observations. *Deep-Sea Research* 45:1389-1405.
- 1998 Connor, R.C., J. Mann, P.L. Tyack, and H. Whitehead. Social evolution in toothed whales. *Trends in Ecology and Evolution* 13:228-232.
- 1998 Tyack, P. Acoustic communication under the sea. In: *Animal acoustic communication: recent technical advances*. (S.L. Hopp M.J. Owren, and C.S. Evans, eds.), Springer Verlag, Heidelberg, pp 163-220.
- 1997 Tyack, P.L. Development and social functions of signature whistles in bottlenose dolphins, *Tursiops truncatus*. *Bioacoustics* 8:21-46.
- 1997 Tyack, P.L. Studying how cetaceans use sound to explore their environment. *Perspectives in Ethology* 12:251-297.
- 1997 Tyack, P.L. and L.S. Sayigh. Vocal learning in cetaceans. In: *Social influences on vocal development*. (Snowdon, C. and M. Hausberger, eds.) pp. 208-233, Cambridge University Press, Cambridge.
- 1996 Fletcher, S., B.J. LeBoeuf, D.P. Costa, P.L. Tyack, and S. Blackwell. Onboard acoustic recording from diving northern elephant seals. *Journal of the Acoustical Society of America*. 100:2531-2539.
- 1995 Sayigh, L.S., P.L. Tyack, R.S. Wells, M.D. Scott, and A.B. Irvine. Sex differences in whistle production of free ranging bottlenose dolphins, *Tursiops truncatus*. *Behavioral Ecology and Sociobiology* 36:171-177.
- 1993 Buck, J. and P.L. Tyack. A quantitative measure of similarity for *Tursiops truncatus* signature whistles. *Journal of the Acoustical Society of America* 94:2497-2506.
- 1993 Freitag, L. and P.L. Tyack. Passive acoustic localization of the Atlantic bottlenose dolphin using whistles and clicks. *Journal of the Acoustical Society of America* 93:2197-2205.
- 1993 Moore, K.E., W.A. Watkins, and P.L. Tyack. Pattern similarity in shared codas from sperm whales (*Physeter catodon*). *Marine Mammal Science* 9:1-9.
- 1993 Tyack, P. Why ethology is necessary for the comparative study of language and communication. In: *Language and communication: comparative perspectives*, (Roitblat, H., L. Herman, and P. Nachtigall, eds.), Erlbaum, Hillsdale NJ, pp. 115-152.
- 1993 Sayigh, L.S., P.L. Tyack, and R.S. Wells. Recording underwater sounds of free-ranging dolphins while underway in a small boat. *Marine Mammal Science*, 9:209-213.

- 1991 Watkins, W.A., and P. Tyack. Response of sperm whales (*Physeter catodon*) to tagging with implanted sonar transponder and radio tags. *Marine Mammal Science*, 7(4):409-413.
- 1991 Tyack, P.L. and C.A. Recchia. A datalogger to identify vocalizing dolphins. *Journal of the Acoustical Society of America* 90(3):1668-1671.
- 1991 Tyack, P. Use of a telemetry device to identify which dolphin produces a sound. In: *Dolphin societies: discoveries and puzzles*, (Pryor, K. and K.S. Norris, eds.), U.C. Press, Berkeley, pp 319-344.
- 1990 Solow, A. and P. Tyack. Inhomogeneity and apparent organization in sequences of animal behavior. *Biometrics*, 46:837-840.
- 1990 Caldwell, M.C., D.K. Caldwell, and P.L. Tyack. Review of the signature whistle hypothesis for the Atlantic bottlenose dolphin, *Tursiops truncatus*. In: *The bottlenose dolphin: recent progress in research*, (Leatherwood, S. and R. Reeves, eds.), Academic Press, San Diego, pp 199-234.
- 1990 Sayigh L.S., P. Tyack, M.D. Scott, and R.S. Wells. Signature whistles in free-ranging bottlenose dolphins, *Tursiops truncatus*: stability and mother-offspring comparisons. *Behavioral Ecology and Sociobiology*, 26:247-260.
- 1987 Watkins, W.A., P. Tyack, K.E. Moore, and G. Notarbartolo-di-Sciara. *Steno bredanensis* in the Mediterranean Sea. *Marine Mammal Science*, 3:78-82.
- 1987 Watkins, W.A., P. Tyack, K.E. Moore, and J.E. Bird. The 20-Hz signals of finback whales (*Balaenoptera physalus*). *Journal of the Acoustical Society of America* 82(6):1901-1912.
- 1986 Tyack, P. Population biology, social behavior, and communication in whales and dolphins. *Trends in Ecology and Evolution*, 1:144-150.
- 1986 Tyack, P. Whistle repertoires of two bottlenosed dolphins, *Tursiops truncatus*: mimicry of signature whistles? *Behav. Ecol. Sociobiol.* 18:251-257.
- 1985 Tyack, P. An optical telemetry device to identify which dolphin produces a sound. *J. Acoust. Soc. Am.* 78:1892-1895.
- 1985 Watkins, W.A., K.E. Moore, and P. Tyack. Sperm whale acoustic behaviors in the southeast Caribbean. *Cetology* 49:1-15.
- 1983 Tyack, P. and H. Whitehead. Male competition in large groups of wintering humpback whales. *Behaviour* 83:132-154.
- 1983 Tyack, P. Differential response of humpback whales to playbacks of song or social sounds. *Behavioral Ecology and Sociobiology* 13:49-55.
- 1983 Payne, K.B., P. Tyack, and R.S. Payne. Progressive changes in the songs of humpback whales. *AAAS Selected Symposia Series*. Boulder: Westview Press, pp 9-59.

- 1982 Tyack, P. Humpback whales respond to sounds of their neighbors. Ph.D. thesis, Rockefeller University, New York.
- 1981 Tyack, P. Interactions between singing Hawaiian humpback whales and conspecifics nearby. *Behavioral Ecology and Sociobiology* 8:105-116.

PAPERS FOR REVIEWED CONFERENCES

- 1999 Johnson, M., P. L. Tyack and D. P. Nowacek. A digital acoustic recording tag for measuring the response of marine mammals to sound. In *OCEANS '99*, Seattle.
- 1999 Johnson, M., P. L. Tyack and D. P. Nowacek. A digital acoustic recording tag for measuring the response of marine mammals to sound. In *International Council for the Exploration of the Seas (ICES)*, Stockholm, Sweden.
- 1998 Nowacek, D.P., P.L. Tyack, R.S. Wells, and M.P. Johnson. An onboard acoustic data logger to record biosonar of free-ranging dolphins. *Proceedings of the 135th Meeting of the Acoustical Society of America*, 1409-1410.
- 1992 Tyack, P., W.J. Williams, and G. Cunningham. Time-frequency fine structure of dolphin whistles. *Proceedings of the IEEE-SP Symposium on Time-frequency and Time-scale Analysis*.
- 1988 Tyack, P. Avoidance characteristics of bowhead whales and migrating gray whales. *Proceedings of the workshop to review and evaluate whale watching programs and management needs*.

POPULAR ARTICLES

- 1999 Tyack P. Playback experiments of loud low frequency sound to singing humpback whales in Hawaiian waters. *Whalewatcher* 37(1):3-12.
- 1998 Tyack P. Protecting marine mammals from the growing problem of ocean noise: opportunities and problems. *MMPA Bulletin* 13:8-9.
- 1992 Tyack, P. Dolphins, belugas, and pilot whales: marine mammal studies at the Woods Hole Oceanographic Institution. *Oceanus*, 35(3):62-64.
- 1991 Tyack, P. If you need me, whistle. *Natural History*, August 1991, pp 60-61.
- 1989 Tyack, P.L., and L.S. Sayigh. Those dolphins aren't just whistling in the dark. *Oceanus* 32(1):80-83.
- 1989 Tyack, P.L. Let's have less public relations and more ecology. *Oceanus* 32(1):103-108.
- 1981 Tyack, P. Why do whales sing? *The Sciences* 2(7):22-25.

TECHNICAL REPORTS AND REVIEWS

- 2000 Biassoni, N., Miller, P.J.O and P.L. Tyack. Preliminary results of the effect of SURTASS-LFA sonar on singing humpback whales. Woods Hole Oceanog. Inst. Tech. Rep., WHOI-2000-06.
- 1998 Clark, C.W. and P.L. Tyack. Quick look low-frequency sound scientific research program phase III: Responses of Humpback Whales to SURTASS LFA off the Kona Coast, Big Island Hawaii 26 February - 31 March, 1998
- 1998 Tyack, P.L. and C.W. Clark. Quick look -- Playback of low frequency sound to gray whales migrating past the central California coast - January, 1998.
- 1998 Clark, C.W., P.L. Tyack, and W.T. Ellison. Quick look, Phase I, Low frequency sound scientific research program.
- 1990 Martin, A., J. Catopovic, K. Fristrup and P. Tyack. VOICE -- A spectrogram computer display package. W.H.O.I. Technical Report No. 90-22.
- 1988 Watkins, W.A., J.E. Bird, K.E. Moore, and P. Tyack. Reference database for marine mammal literature. W.H.O.I. Technical Report No. 88-2.
- 1987 Malme, C.I., B. Würsig, J.E. Bird, and P. Tyack. Observations of feeding gray whale responses to controlled industrial noise. Reports of the Ninth International Conference on Port and Ocean Engineering under Arctic Conditions, 17-22 Aug 1987, Fairbanks AK, The Geophysical Institute, University of Alaska.
- 1986 Malme, C.I., B. Würsig, J.E. Bird, and P. Tyack. Behavioral responses of gray whales to industrial noise: feeding observations and predictive modeling. Bolt Beranek and Newman Report No. 6265 submitted to NOAA, Anchorage, AK.
- 1985 Malme, C.I., P.R. Miles, P. Tyack, C.W. Clark, and J.E. Bird. Investigations of the potential effects of underwater noise from petroleum industry activities on feeding humpback whale behavior. Bolt Beranek and Newman Report No. 5851 submitted to Minerals Management Service, U. S. Dept. of the Interior.
- 1984 Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Phase II: January 1984 migration. Bolt Beranek and Newman Report No. 5586 submitted to Minerals Management Service, U. S. Dept. of the Interior.
- 1983 Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. Investigations of the potential effects of underwater noise from petroleum

industry activities on migrating gray whale behavior. Bolt Beranek and Newman Report No. 5366 submitted to Minerals Management Service, U. S. Dept. of the Interior.

POLICY-RELATED PAPERS, REVIEWS, AND TESTIMONY

- 2002 Brief California Coastal Commission on plans for scientific research on marine mammals – validation test of a whale finding sonar with migrating gray whales, San Francisco CA, 12 Dec 2002
- 2002 Declaration on effects of SURTASS LFA sonar on marine mammals. Expert witness for U.S. Department of Justice. October, November 2002
- 2002 Briefing to US Senate Commerce Committee on National Academies 2000 report on marine mammals and low frequency sound, Dirksen Building, Washington DC 17 May 2002
- 2000 Briefing to Ocean Studies Board on marine mammals and low frequency sound, National Academy of Sciences, Woods Hole MA, 17-19 July 2000
- 2000 Briefing to federal regulators on marine mammals and low frequency sound, National Academy of Sciences, Washington DC, 30 May 2000
- 2000 Briefing to House and Senate committees on Armed Services and Commerce on marine mammals and low frequency sound, Washington DC, 30 May 2000
- 1999 Brief California Coastal Commission on scientific results of phase II of SURTASS LFA marine mammal research, Santa Rosa CA, 12 May 1999.
- 1999 Brief Minority Staff Director of House Committee on Armed Services on effects of noise on marine mammals, WHOI, 2 April 1999.
- 1997 Brief California Coastal Commission on plans for phase II of SURTASS LFA marine mammal research, San Rafael CA, 12 December 1997.
- 1997 Research priorities for using a naval low frequency sound source in order to study effects of noise in free-ranging marine mammals. Discussion paper to introduce the research opportunity presented by naval source and to frame issues for discussion at a 23 May 1997 workshop.
- 1996 Marine mammals and low frequency sound: progress since 1994 – an interim report. Committee to Review Results of ATOC's Marine Mammal Research Program. Ocean Studies Board, National Research Council
- 1996 Scoping comments regarding U.S. Navy planned Environmental Impact Statement on Low Frequency Sonar
- 1995 Comments on proposed rule regarding small takes of marine mammals; harassment takings incidental to specified activities. Office of Protected Resources, National Marine Fisheries Service.

- 1994 Testimony to U.S. House of Representatives Subcommittee on Merchant Marine and Fisheries concerning reauthorization of the Marine Mammal Protection Act. 10 February 1994
- 1992 Comments on proposed regulations on approaching marine mammals, Office of Protected Resources, National Marine Fisheries Service.
- 1992 Review of proposed Transition Options, Applied Research and Technology Directorate, Office of Naval Technology, 25 February 1992.
- 1991 Tyack, P.L. Comments on Draft Legislative Environmental Impact Statement regarding commercial fisheries interactions with marine mammals.
- 1991 Tyack, P.L. Review of "Reducing dolphin mortality from tuna fishing." Requested by the National Research Council Board on Environmental Studies and Toxicology.
- 1990 Watkins, W.A. and P.L. Tyack. Biological impact of Heard Island experiment on marine mammals. Testimony requested by N.O.A.A. and Marine Mammal Commission.
- 1989 Tyack, P. Comments on NMFS review of the policy by which permits are issued for scientific research on marine mammals.
- 1988 Tyack, P. Review of evidence concerning the effects of vessel traffic on the distribution of humpback whales in Hawaiian waters. Legal affidavit filed by the Sierra Club Legal Defense Fund.
- 1986 Tyack, P. Comments on proposed regulations concerning boats and aircraft near humpback whales in Hawaiian waters.

GRADUATE STUDENTS SPONSORED

WHOI/MIT JOINT PROGRAM:

Susan Parks, 1998-

Stephanie Watwood, 1997-

Sarah Marsh, (co-advising with Darlene Ketten), 1998-2001

Rebecca Thomas, 1995-2001

Patrick Miller, 1994-2000

Douglas Nowacek, 1993-1999

Deborah Redish, 1992-1998

Cheri Recchia, 1988-1994

Liese Siemann, 1988-1994

Laela Sayigh, 1986-1992

WHOI PhD PROGRAM
Amy Samuels, 1990-1996

POSTDOCTORAL SCHOLARS AND FELLOWS SPONSORED

Rebecca Thomas 2001-2002
Patrick Miller 2000-2002
Doug Nowacek 2000-
Aaron Thode, (primarily MIT OE) 2000-2001
Vincent Janik, 1998-2001
Raquel Jaakkola, 1997-1999
Andrew Read, 1990-93
Richard Connor, 1991-92.
Randall Wells, 1987-89.

THESIS COMMITTEES

Chair: Gorka Sancho, PhD student in Biology, WHOI/MIT Joint Program.
Chair: Linda Martin, PhD student in Biology, WHOI/MIT Joint Program.
David Mann, PhD student in Biology, WHOI/MIT Joint Program.
Kevin Christian, PhD student in Electrical Engineering and Computer Science, MIT.
Karen Moore, masters student in Biology at U. Mass., Boston.
Brenda McCowan, PhD student in Biological Anthropology, Harvard University.
Ania Driscoll-Lind, masters student in Biology at U.C. Santa Cruz.
David Kastak, PhD student in Biology at U.C. Santa Cruz.
Cheryl Aday, PhD student in Biology, Boston University.
Jennifer Miksis, Masters student, Univ of Mass. at Dartmouth
Jennifer Hammock, PhD student in Biology, WHOI/MIT Joint Program.
Edward Owen, PhD student in marine sciences, UC Santa Cruz
Brandon Southall, PhD student in marine sciences, UC Santa Cruz
Kara Buckstaff, Masters student in marine sciences, UC Santa Cruz
Ester Quintana-Rizzo, Masters student, FSU
Marcia Frame, Masters student in Biology, University of Western Florida
Jennifer Miksis, PhD student, Univ of Rhode Island

SUMMER STUDENTS AND GUEST STUDENTS

Janet McIntosh, Radcliffe College, Summer student fellow, 1991
Hugh Morgenbesser, MIT, UROP, 1993
Morgan Collins, Summer 1996
Jen Miksis, Radcliffe College, 1996-2000
Pam Willis, Fall 1996
Amanda Searby, École Normale Supérieure, Summer student fellow, 1997
Ari Shapiro, Boston College, Summer student fellow, 2000

Aura Obando, Duke University, Summer student fellow, 2001

COURSES TAUGHT

Marine mammals, with John Reynolds, Daniel Rubenstein and Randall Wells, Eckerd College and Mote Marine Lab, Sarasota FL, July 1999

Topics in the Behavior of Marine Animals, MIT Biology course 7.438, Spring 1996, 1997, 1999.

Communication and social behavior in bottlenose dolphins, with Randall Wells and Linda Farmer, University of Miami Marine Sciences MSC 411, January 1999

Dolphin and Whale Biology, with Daniel Rubenstein and Randall Wells, Duke University course BIO 196S.08, July 1992.

Marine Bioacoustics, MIT Biology course 7.415, Spring 1990.

Marine Mammals and Coastal Management, with Susan Peterson, Boston University Marine Program, Fall 1989.

COURSE LECTURES

Animal Behavior/Behavioral Ecology/Marine Mammals section of MIT Biology course 7.47 on Biological Oceanography taught by WHOI Biology staff. Spring 1986-93.

Marine Mammal Communication, Massachusetts Bay Marine Studies Consortium, University of Massachusetts at Boston, Springs 1988-1993.

Human-Animal Relationships, Tufts School of Veterinary Medicine, Prof. Elizabeth Lawrence, Oct 1986.

Marine Ecology, Boston University Marine Program, Prof. Ivan Valiela, Fall 1988.

Social Cognition, Harvard Anthropology Department, Instructor Peter Frumhoff, Fall 1988.

Marine Biology, Boston University Biology Department, Prof. Rudi Strickler, Spring 1990.

Echolocation, Brown University, Department of Psychology, Prof. James Simmons, Spring 1993.

Evolution and Cognition, Joint Harvard/MIT course, Departments of Anthropology and Psychology (Harvard) and Brain and Cognitive Sciences (MIT), Professors Marc Hauser and Steven Pinker, Spring 1994.

Marine Biology, Boston University Biology Department, Prof. Jelle Atema, Springs 1993-4.

Marine mammalogy, University of California at Santa Cruz, Prof. Daniel Costa, Spring 1994-5.

Environmental Impact of seismic exploration “noise.” Stanford University Department of Geophysics, Dr. Ginger Barth, Fall 1994.

Marine mammals, Boston University Biology Department, Prof. Natalie Ward, Falls 1993 and 1995.

Bioacoustics workshop, UC Santa Cruz, August 1995.

Social signaling in cetaceans, Marine Mammal Bioacoustics short course, sponsored by the Acoustical Society of America, Orlando FL 12-13 Dec 1995.

Marine mammal communication, Animal Behavior, Brown University, Prof. Andrea Simmons. 11 Feb 1998.

Effects of noise on marine mammals, Marine Mammals, Brandeis University, Prof. James Hain. Dec 1998.

Marine mammal bioacoustics, MIT 13.00 Intro to Ocean Engineering, Prof. John Leonard. October 2000.

Communication and Cognition, BUMP course on Marine Mammals, Prof. Nathalie Ward, Nov 2000.

Cetacean Biology, New England Marine Studies Consortium and conducted at Brandeis University, 29 March, 19 April 2001, 3 April 2003.

WORKSHOPS AND PANELS

- | | |
|------|--|
| 1997 | Maritime operations and marine mammals, Marine Board, National Research Council. Washington DC, 31 January 1997. |
| 1997 | Shipping/right whale workshop, Boston MA 17-18 April 1997. |
| 1998 | ONR workshop on effects of man-made noise on the marine environment. Washington DC, 9-12 February 1998. |
| 1998 | Bioacoustics Panel for NATO meeting to review strandings of beaked whales, La Spezia Italy, 15-17 June 1998. |

- 1998 Workshop on Acoustic Criteria, National Marine Fisheries Service Office of Protected Resources Silver Spring MD 9-12 September 1998.
- 1999 Navy Marine Mammal Requirements Workshop, Crystal City, 7-8 April 1999.
- 1999 Committee to review results of ATOC's Marine Mammal Research Program, San Diego CA, 12-14 April 1999.
- 1999 Advisory Board meeting of the ATOC Marine Mammal Research Program, Ithaca NY, 19-21 June 1999.
- 2000 Attend NOAA 2002 Priorities and Planning Workshop, Washington, D.C Feb. 10-11 2000.
- 2000 Meeting for scientific review of LFA EIS, Cornell University, Ithaca NY, March 8-9 2000.
- 2000 Attend workshop on beaked whales, European Cetacean Society, Cork, Ireland, 31 March -3 April 2000.
- 2000 Attend workshop on databases of animal sounds, Univ of Penn, Philadelphia, PA, 12-13 May 2000.
- 2000 Environmental Consequences of Underwater Sound, Arlington VA, 19-20 July 2000.
- 2000 Workshop on effects of oil industry sounds on marine mammals, Newport Beach, CA, Dec 00
- 2001 ONR workshop on Ocean Acoustics, Dallas TX, 4-5 Jan 01
- 2001 IFAW Workshop on Right Whale Acoustics, Woods Hole, March 2001
- 2001 Workshop on Responses of Marine Mammals to Controlled Exposures of Manmade Noise, European Cetacean Society, Rome, May 2001
- 2001 Workshop to review LFA EIS and controlled exposure experiments, Boston, April 01
- 2001 Workshop on Vessel Collision, European Cetacean Society, Rome, May 2001
- 2000 Workshop on Acoustic Harassment Devices, Rome, Istituto Centrale per Ricerca Applicata al Mare, 4-5 May 2001
- 2002,3 NMFS Noise Exposure Criteria Workshops, July 2002, Feb 2003

SYMPOSIA CONVENED, SESSIONS CHAIRED

Co-convened (with Giuseppe Notarbartolo di Sciara, Museum of Natural History, Milan) an international workshop on the social structures of cetaceans. Part of the Fifth International Theriological Congress, Rome, 29 August 1989.

Chaired Session on Communication and Behavior, Ninth Biennial Conference of the Society for Marine Mammalogy, Chicago IL 8 December 1991.

Chaired Session entitled Animal Bioacoustics: Animal Communication at the 133rd meeting of the Acoustical Society of America, State College PA 19 June 1997.

Co-organized (with Vincent Janik, WHOI) symposium on vocal communication in delphinids, Society for Marine Mammalogy, Conference on the biology of marine mammals, Maui HI, 28 November - 3 December 1999.

Co-organizer (with Frans de Waal; Emory University) of conference on Animal Social Complexity, Chicago Academy of Sciences, 23-26 Aug 2000.

Host, IFAW Workshop on Right Whale Acoustics, Woods Hole, March 2001

Convenor, Workshop to review LFA EIS and controlled exposure experiments, Boston, April 01

Co-convenor, Workshop on Responses of Marine Mammals to Controlled Exposures of Manmade Noise, European Cetacean Society, Rome, May 2001

Co-chaired session with Gianni Pavan, University of Pavia, on New Techniques European Cetacean Society, 12 March 2003, Las Palmas, Gran Canaria Spain

Resume of Peter Teglberg Madsen (030603)

Personal Data:

Full name Peter Teglberg Madsen

[REDACTED]

Contact info Phone: 0045-86106814, email (shore): Peter.Teglberg@biology.au.dk, email (sea):
odysseyo@oceanallaince.org (write for Madsen in heading)

Education:

1994 Graduated from High school, Herning, Denmark.

1997 B.Sc. at Dept. of Zoophysiology, Aarhus University: "Click rates of an echolocating Harbour porpoise"

2000 M.Sc. at the Dept. of Zoophysiology, "Sound production in Sperm whales"

2001 PhD. Dissertation, November 5, 2002. "Sperm whale sound production". Opponents: Dr. Peter Tyack (WHOI), Dr. Mats Amundin (Linköping University), Dr. Roy Weber (University of Aarhus).

Employment:

2002 Post doc. at the Whale Conservation Institute (MA, USA) and Chief Scientist of the RV Odyssey working in the Indian Ocean. (Started 11 November, 2002)

Papers in peer-reviewed, international journals:

2000

1. Madsen P.T., and Møhl B., (2000), "Sperm whales (*Physeter catodon* L. 1758) do not react to sounds from detonators," *J. Acoust. Soc. Am.* 107, 668-671.

2. Møhl B., Wahlberg M., Madsen P.T., Miller L. A. and Surlykke A. (2000), "Sperm whale clicks: Directionality and Source level revisited," *J. Acoust. Soc. Am.* 107, 638-648.

2001

3. Wahlberg M., Møhl B. and Madsen P.T. (2001), "Estimating source position accuracy of a large aperture hydrophone array used for bioacoustics," *J. Acoust. Soc. Am.* 109(1), 397-406.

2002

4. Madsen P.T., R. Payne, N.U. Kristiansen, M. Wahlberg, I. Kerr and B. Møhl (2002), "Sperm whale sound production studied with ultrasound-time-depth recording tags". *J. Exp. Biol.* 213, 1899-1906.

5. Madsen P.T., B. Møhl, B. K. Nielsen and M. Wahlberg (2002), "Sperm whale behavior during exposures to remote air gun pulses and artificial codas" *Aq. Mam.* 28(3): 231-240.

6. Teilman J., L. Miller, T. Kirketerp, R. Kastelein, Madsen P.T., Nielsen B.K. and Au W.W. (2002), "Characteristics of echolocation signals used by a harbour porpoise (*Phocoena phocoena*) during target detection." *Aq. Mam.* 28(3): 275-284.

7. Madsen P.T., M. Wahlberg and B. Møhl (in press), "Male sperm whale (*Physeter macrocephalus*) acoustics in a high latitude habitat: implications for echolocation and communication" *Behav. Ecol. Sociol.* 53: 31-41.

8. Møhl B., P.T. Madsen, M. Wahlberg, W.W.L. Au, P. Nachtigall and S. Ridgway (2002), "Sound transmission in the spermaceti complex of a recently expired sperm whale calf". *Acoustical Research Letters Online* 4(1): 19-24.

2003

9. Madsen P.T., D. Carder, W.W.L. Au, B. Møhl, P. Nachtigall and S.H. Ridgway (in press) "Sound production in sperm whale neonates". *J. Acoust. Soc. Am.*

10. Møhl B., M. Wahlberg, P.T. Madsen, A. Heerford and A. Lund (in press) "The monopulsed nature of sperm whale sonar clicks" *J. Acoust. Soc. Am.*

Submitted

11. Madsen P.T., R. Payne, M. Wahlberg and B. Møhl (submitted) "Do sperm whale clicks change pitch with increasing hydrostatic pressure?"

Two additional manuscripts are in the final stage before submission

Other publications

1. Teilman J., L. Miller, T. Kirketerp, R. Kastelein, Madsen P.T., Nielsen B.K. and Au W.W. (2001), "Characteristics of echolocation signals used by a harbour porpoise (*Phocoena phocoena*) during target detection," in Teilman J. "The behavior and sensory abilities of harbour porpoises (*Phocoena phocoena*) in relation to by-catch in Danish gillnet fishery," PhD.thesis. University of Southern Denmark.
2. Madsen P.T. (2002) "Morphology of the sperm whale nasal complex: A review and some new findings" in: Madsen P.T. "Sperm whale sound production", PhD. Dissertation, Department of Zoophysiology. University of Aarhus. Denmark
3. Madsen P.T. (2002) "Sperm whale sound production - in the acoustic realm of the biggest nose on record" in: Madsen P.T. "Sperm whale sound production", PhD. Dissertation Department of Zoophysiology. University of Aarhus. Denmark
4. Madsen P.T. (2003) "Sperm whale acoustics in a noisy world" Proceedings of MMS Information Transfer Meeting, Kenner, Louisiana, USA

Popular scientific publications

1. Jørgensen J. M., Lomholt J. P., Madsen P. T., Nielsen J. E. (1999), "Slimålene - De mest oprindelige nulevende hvirveldyr". Naturens Verden (6) pp. 12-17. (in Danish)
2. Madsen P.T. (2002) "Store næser og store sugekopper - kaskelotters lydproduktion på dybt vand". Aktuell Naturvidenskab. (in danish). This article has also appeared in Jyllands Posten.

Field work and sea duty:

- * Andenes 1998: Two-month expedition off Northern Norway (N69, E15) with r/v Narhvalen, deploying a large aperture hydrophone array for research on Sperm whale acoustics. Collaboration with Bertel Moehl and Magnus Wahlberg.
- * Andenes 2000: Two-month expedition off Northern Norway (N69, E15) with r/v Narhvalen, deploying a large aperture hydrophone array for research on Sperm whale acoustics. Collaboration with Bertel Moehl and Magnus Wahlberg.
- * Bismarck Sea 2001: One-month expedition off Papua New Guinea (S4, E147) with r/v Odyssey, deploying ultrasound-time-depth recorders on Sperm whales. Collaboration with Dr. Roger Payne and Iain Kerr, Ocean Alliance/ The Whale Conservation Institute: www.oceanalliance.org
- * Indian Ocean (2002-2003): 9 months as Chief scientist onboard the r/v Odyssey of the Ocean Alliance. Collaboration with Dr. Roger Payne and Iain Kerr, Ocean Alliance/ The Whale Conservation Institute: www.oceanalliance.org

Research visits:

- * Hawaiian Institute for Marine Biology, Drs. W.W. Au and P. Nachtigall (2001)
- * SCS, San Diego; Drs. S.H. Ridgway and T. Cranford (2001)
- * Kolmården Djurpark, Sweden; C. Blomquist and Dr. M. Amundin (2002)

Funding:

- * The PhD. study was funded by the Faculty of Science, University of Aarhus. (1998-2002)
- * Novo Nordisk Science Foundation, 10.000 U\$ for the project: "Acoustic Instrumentation of Sperm whales". (1999)
- * Fieldwork off Andenes was funded by the Danish Research Foundation through Center for Sound Communication, Odense University. (1998-2000)
- * Fieldwork in the Bismarck Sea was funded by Ocean Alliance/The Whale Conservation Institute and Dept. of Zoophysiology, University of Aarhus. (2001)
- * The Oticon Foundation, 4.000 U\$ for the project: "Acoustic communication in Sperm whales". (2001)
- * Novo Nordisk Science Foundation, 17.000 U\$ for the project: "Acoustic instrumentation of toothed whales" (2003).
- * SNF 16.000 U\$ for the project "Sound production in deep-diving odontocetes"

Presentations:

Poster or oral presentations

ICA (Rome, 2001)

MMC (Vancouver, 2001)

DHM (Århus, 2002).

Invited speaker at US Minerals Management Service hearing on Sperm whales and air guns in The Gulf of Mexico (January 15th , 2003)

Invited seminars

Marine Mammal Research Program, Hawaii Institute of Marine Biology (Hawaii, 2001)

SSC (San Diego, 2001)

Center for Sound Communication, University of Southern Denmark (Odense, 2001)

Seminars at the Department of Zoophysiology, University of Aarhus

Four talks in the period 1998-2002 on sperm whale acoustics, morphology and thermoregulation

Software:

* Word processing: Microsoft office

* Sound analysis: Cool Edit, Gold wave, Batsound, Sigpro, Rainbow click

* Databases: Access, Logger 2000

* Programming: Matlab

Teaching:

More than 30 lectures in animal physiology, marine biology and vertebrate anatomy at various undergraduate and graduate courses at the Biological Institute, University of Aarhus from 2000-2002.

* Lecturer in Chordate Anatomy: Autumn 2000, 2001 and 2002

* Lecturer in the Marine Mammal part of Marine Biology: Autumn 2000, 2001 and 2002.

* Lecturer in Zoophysiology; Neuro and Sensory Physiology: Autumn 2001

* Founder of Vertebrate Ecophysiology: Autumn 2002

* Assistant teacher in Chordate Anatomy: Spring 1997, Autumn 1998, 1999, 2000, 2001 and 2002.

* Assistant teacher in Stream Ecology: Spring 1999 and 2000.

* Guest teacher at "Natur I Teltet": Autumn 1999 and 2000.

* Popular talks on marine mammals, anatomy and physiology at UNF (Denmark, 2001), "Tilbudstimer" (Denmark, 1999; 2001) and at various public schools.

Currently supervising two bachelor and one master student.

Miscellaneous

Coastal skipper certificate

End Resume of Peter Teglberg Madsen

Michela A. Podestà

Curriculum vitae

February 2003



Education

Scientific Diploma at the high school "Liceo Scientifico Leonardo da Vinci" in 1978.

Degree in Natural Sciences at the University of Milan in 1986, with a thesis on the cetaceans of the Ligurian Sea (sightings and strandings).

Work

Position (since 1991): Curator of the Vertebrate Zoology Department of the Natural History Museum of Milan (MSNM).

Other main activities:

Contract Professor at the Veterinary University of Padoa, Academic year 1999/2000 (Anatomy of the Wild Italian Mammals).

Foundation member of the "Centro Studi Cetacei" (Italian Society for Cetacean Studies) and member of the board of governors (1986-today).

Coordinator of the national "Stranding Project" (Italian Stranding Network) of the Centro Studi Cetacei and Editor of the reports published yearly on the cetaceans found stranded along the Italian coasts (1992-today).

Coordinator of the visual team for the sightings of marine mammals during the research cruises organised by the Nato Saclant Undersea Research Centre in Ligurian and Tyrrhenian Sea, RV Alliance (2001 - today).

Cooperation to the management in the SOLMAR project (Saclantcen) since its early stages (study of marine mammals, develop of Acoustic Risk Mitigation Policies and set up of databases and GIS of Mediterranean strandings and sightings).

Foundation member of the European Cetacean Society and member of the Council (1987-1990).

As curator of MSNM, in addition to the museum work, she is involved in the following main scientific activities:

- participation in research cruises in the Mediterranean for the study of marine mammals with sightings and acoustic techniques;
- study of some aspects of cetacean biology through the analysis of stranded specimens;
- national representative in international committees;
- participation to scientific national and international congresses;
- member of the organizer committee for national scientific congresses;
- referee for scientific journals.

Scientific papers

Cagnolaro L., Cozzi B., Magnaghi L., Podestà M., Poggi R., Tangerini P., 1986 - Su 18 cetacei spiaggiati sulle coste italiane dal 1981 al 1985. Rilevamento biometrico ed osservazioni necroscopiche (Mammalia Cetacea) - Atti Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano, 127: 79-106.

Magnaghi L., Podestà M., 1987 - An accidental catch of 8 Striped Dolphins (*Stenella coeruleoalba*) in the Ligurian Sea (Cetacea, Delphinidae) - Atti Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano, 128: 235-239.

Podestà M., Magnaghi L., 1987 - La costituzione della "European Cetacean Society" - Notiziario S.I.B.M., 11: 52-53.

Podestà M., Notarbartolo di Sciara G., 1987 - The "Centre for Cetacean Studies" of the Italian Society of Natural Sciences: its founding and activities - ECS Newsletters, 1: 26-27.

Podestà M., Magnaghi L., 1988 - Avvistamento di tursiopi, *Tursiops truncatus*, in prossimità della costa ligure - Atti Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano, 129: 393-395.

Podestà M., Magnaghi L., 1988 - Cattura di un *Cetorhinus maximus* nel Mar Ligure - Atti Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano, 129: 453-458.

Podestà M., Magnaghi L., 1988 - Sightings of Pilot Whales, *Globicephala melaena*, in the Ligurian Sea, 1981-1988 - Atti Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano, 129: 478-482.

Cagnolaro L., Magnaghi L., Podestà M., Jann B., 1989 - False Killer Whale: a rare stranding for the Italian coasts - European Research on Cetaceans - 3 - Proc. 3rd Annual Conference of the European Cetacean Society, La Rochelle, 24-26 February 1989: 65-66.

Podestà M., Magnaghi L., 1989 - Unusual number of Cetacean by-catches in the Ligurian Sea - European Research on Cetaceans - 3 - Proc. 3rd Annual Conference of the European Cetacean Society, La Rochelle, 24-26 February 1989: 67-70.

Podestà M., Meotti C., 1991 - The Stomach Contents of a *Ziphius cavirostris* and a *Grampus griseus* stranded in Italy - European Research on Cetaceans - 5 - Proc. 5th Annual

- Conference of the European Cetacean Society, Sandefjord, 21-23 February 1991: 58-61.
- Zaniboni A., Vismara C., Scari G., Podestà M., Cagnolaro L., Leone V.G., 1991 - Adaptive radiation features in Odontocete eye (*Stenella coeruleoalba*) - European Research on Cetaceans - 5 - Proc. 5th Annual Conference of the European Cetacean Society, Sandefjord, 21-23 February 1991: 115-117.
- Manfredi M.T., Dini W., Ganduglia S., Podestà M., 1992 - Parasitological findings in striped dolphins - European Research on Cetaceans - 6 - Proc. 6th Annual Conference of the European Cetacean Society, San Remo, 20-22 February 1992: 218-219.
- Podestà M., Marsili L., Focardi S., Manfredi M.T., Mignone W., Genchi C., 1992 - Ricerche patologiche, parassitologiche e sulla presenza di xenobiotici in *Stenella coeruleoalba* (Meyen, 1833) (Mammalia, Cetacea) - Atti Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano, 133(9): 101-112.
- Cagnolaro L., Notarbartolo di Sciara G., Podestà M., 1993 - Profilo della Cetofauna dei mari italiani - Suppl. Ric. Biol. Selvaggina, XXI: 101-114.
- Podestà M., 1993 - Cetacei - Guida all'esposizione cetologica del Museo civico di Storia Naturale di Milano - Giunti ed., 48 pp.
- Meotti C. and Podestà M., 1996 - Stomach contents of *Stenella coeruleoalba* (Meyen, 1833) from the Western Ligurian Sea - Atti Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano, 137 (I-II): 5-15.
- Podestà M., Magnaghi L. & Gorlier G.G., 1997 - Sightings of Risso's dolphin in the Ligurian waters - European Research on Cetaceans, 11: 167-169.
- Podestà M., Bortolotto A., Borri M. & Cagnolaro L., 1997 - Ten years of activity of the Italian Centro Studi Cetacei - European Research on Cetaceans, 11: 83-86.
- Borri M., Cagnolaro L., Podestà M., Renieri T. (a cura di), 1997 - Il Centro Studi Cetacei: dieci anni di attività. 1986-1995 - Natura, 88(1), 93 pp.
- Di Giancamillo M., Rattegni G., Podestà M., Cagnolaro L., Cozzi B. & Leonardi L., 1998 - Postnatal ossification of the thoracic limb in striped dolphins (*Stenella coeruleoalba*) (Meyen, 1833) from the Mediterranean sea - Canadian Journal of Zoology, 76: 1286-1293.
- Fossati C., D'Amico A., Portunato N., Pavan G., Podestà M., 1999 - Application of geographical digital tools to stranding information - European Research on Cetaceans, 13: 465-466.
- Cagnolaro L. e Podestà M., 1999 - Cetacei - pp. 185-198 - in: Spagnesi M. e Toso S. (a cura di), Iconografia dei Mammiferi d'Italia, Ministero dell'Ambiente, Servizio Conservazione Natura, Istituto Nazionale per la Fauna Selvatica.
- Pertoldi C., Podestà M., Loescheke V., Schandorff S., Marsili L., Mancusi C., Nicolosi P. & Randi E., 2000 - Effect of the 1990 die-off in the northern Italian seas on the developmental stability of the striped dolphin *Stenella coeruleoalba* (Meyen, 1833) - Biological Journal of the Linnean Society, 71: 61-70.
- D'Amico A., Podestà M. and Teloni V., 2000 - Cetacean visual sightings in Sirena 99 - a sound, oceanography and living marine resources project research cruise - European Research on Cetaceans, 14: 364-368.
- Mancusi C., Nicolosi P., Arculeo M., Barbagli F., Carlini R., Costantini M., Doria G., Fabris G., Maio N., Mattioli G., Mizzan L., Podestà M., Salmaso R., Vanni S., Zuffi M., Serena F. & Vacchi M., 2000 - The presence of Elasmobranchs in the collections of the main


- Italian Natural History Museums- Proc. 4th Europ. Elasm. Assoc. Meet., Livorno, Vacchi M., La Mesa G., Serena F. & Séret B., eds., ICRAM, ARPAT & SFI, 2002: 97-108.
- Laist D.W., Knowlton A.R., Mead J.G., Collet A.S., Podesta' M., 2001 - Collisions between ships and whales - *Marine Mammal Science*, 17(1). 35-75.
- Podestà M. & Bortolotto A., 2001 - Il Progetto Spiaggiamenti del Centro Studi Cetacei: analisi dei risultati di 11 anni di attività - pp. 145-158 - in: Borri M., Cagnolaro L., Podestà M., Renieri T. (a cura di), 2001 - Atti del 3° Convegno Nazionale sui Cetacei - *Natura*, 90(2), 208 pp.
- Podestà M., Rattegni G., Leonardi L., Cagnolaro L., Cozzi B. & Di Giancamillo M., 2001 - Criteri per la determinazione dell'età sulla base dello sviluppo scheletrico dell'arto toracico in *Stenella coeruleoalba* (Meyen, 1833) del Mediterraneo - pp. 159-162 - in: Borri M., Cagnolaro L., Podestà M., Renieri T. (a cura di), 2001 - Atti del 3° Convegno Nazionale sui Cetacei - *Natura*, 90(2), 208 pp.
- Borri M., Cagnolaro L., Podestà M., Renieri T. (a cura di), 2001 - Atti del 3° Convegno Nazionale sui Cetacei - *Natura*, 90(2), 208 pp.
- Valsecchi E., Raga J.A., Podestà M., Sherwin W., in press - Population genetics of the Mediterranean striped dolphin (*Stenella coeruleoalba*) and molecular assessment on the effects of the 1990-1992 morbillivirus epizootic - *European Research on Cetaceans* (Rome).
- Zotti A., Podestà M., Cozzi B., Bernardini D., Di Giancamillo M., Guglielmini C., in press - Bone density in the striped dolphin's thoracic limb: a tool for development and age definition - *European Research on Cetaceans* (Rome).
- D'Amico A., Mineur F., Alvarez A., Mori C., Podestà M., Portunato N., Ballardini M., Nani B., 2001 - Oceanographic Correlations with the Distribution of Cuvier's Beaked Whales (*Ziphius cavirostris*) in the Ligurian Sea - 14th Biennial Conference on the Biology of Marine Mammals, Vancouver, Canada. Abstracts, 52.
- Guglielmini C., Zotti A., Bernardini D., Pietra M., Podestà M., Cozzi B., 2002 - Bone Density of the Arm and Forearm As An Age Indicator in Specimens of Stranded Striped Dolphins (*Stenella coeruleoalba*) - *The Anatomical Record*, 267: 225-230.
- Pesante G., Collet A., Dhermain F., Frantzis A., Panigada S., Podestà M., and Zanardelli M., 2002 - Review of collisions in the Mediterranean Sea - *European Cetacean Society Newsletter* n. 40 (Spec. Issue): 5-12.
- Pavan G., Podestà M., D'Amico A., Portunato N., Fossati C., Manghi M., Priano M., Teloni V., Mori C., Quero M., in press - A GIS and associated database for the Italian stranding network. A cooperative project based on GIS technologies - *European Research on Cetaceans* (Liege).

Kenneth A. Shorter



Email: kshorter@whoi.edu

Education

University of Colorado, Boulder - Graduated 2001 - 
BS in Mechanical Engineering, August, 2001



Work Experience

Professional

July 2001 to Present - Woods Hole Oceanographic Institution - Engineer I

I am currently working at WHOI on various marine mammal tagging projects and other small oceanographic engineering projects. In these, I am responsible for the design and production of noninvasive attachment devices that are used to secure electronic tags to manatees, right whales, sperm whales, humpback whales and beaked whales. I also am responsible for the design and manufacture of mechanical parts and structures to aid in the deployment of the tags. The small ocean engineering projects include the design and manufacture of pressure housings, protective cages for electronics, and mold positives. As a member of several marine mammal research projects I have worked in Belize City (Belize) in March 2002 putting noninvasive tags on manatee to study the behavioral response of the animal to controlled boat approaches; done fieldwork in Grand Manan (Canada) in July and August of 2001 and 2002 putting noninvasive tags on North Atlantic right whales to study the behavioral response to large vessel traffic; participated in ship based fieldwork off the coast of Massachusetts (USA) in September 2002 tagging humpback whales to demonstrate the feasibility of the attachment methods on humpback whales. I have been responsible for all tag related activity on the 2002 manatee and humpback whale experiments and shared that same responsibility for the right whale experiments. These responsibilities included the mobilization of the equipment for the experiment preparation of the tag for deployment, the deployment of the tag on the animals, the recovery of the tag, initial processing of the data collected during the deployment, and the demobilization of the tagging equipment.

Summers from June 1999 to July 2001 - Woods Hole Oceanographic Institution - Guest Student

I was a member of three field experiments involving the collection of data from whales. I was responsible for the design and production of a noninvasive attachment device that was successfully used to attach a sensor package to North Atlantic right whales and sperm whales. I was responsible for the field deployment and maintenance of the tag as well as behavioral data collection. One field experiment was conducted from on-board

the National Marine Fisheries Service Research Vessel Gordon Gunter. Others used small sailing and fishing boats in the Bay of Fundy,

Academic

August 2000 to December 2000 - University of Colorado - Teaching Assistant
As a TA for CVEN 3111 - Vector Mechanics II/Dynamics, worked in the Civil and Environmental Engineering Department to TA its section of Dynamics. Responsibilities included: proctoring and grading exams, and maintaining weekly office hours.

January 1998 to May 1999 - University of Colorado - Teaching Assistant
Because of my computing proficiency in Excel, Matlab, and Fortran I was invited in my second semester of freshman year by Professor John O. Dow to work as a teaching assistant for GEEN 1300 - Introduction to Engineering Computing, an introductory engineering computing class. The class taught first year engineering students skills in Excel, Matlab and Fortran. I was responsible for a lab session containing approximately twenty-five students each semester. These responsibilities included: the creation and implementation of weekly labs, the grading of those labs and subsequent exams, the presentation of material to the students to supplement the lecture material, and weekly office hours. I performed this job for four consecutive semesters for three different professors.

May 1998 to August 1998 - University of Colorado - Lesson Planner
The professors teaching GEEN 1300 - Introduction to Engineering planned to use a different format than that in previous semesters. I was responsible for the selection and presentation of lab material used in the new version of GEEN 1300. This material was then incorporated into future offerings of the class.

August 1997 to December 1997 - University of Colorado - Graphic Artist
I worked with a University Professor to design and draw using Auto-CAD approximately 150 figures for a textbook.

Publications

1. Doug P. Nowacek, Mark P Johnson, Peter L. Tyack, Kenneth A. Shorter, William A. McLellan, D. Anne Pabst. 2001. "Buoyant Balaenids: the ups and downs of buoyancy in right whales." PROC. R. SOC. LOND. B 268: 1811-1816.
2. Stephanie M. Nowacek, Douglas P. Nowacek, Mark P. Johnson, Kenneth A. Shorter, James A. Powell, and Randall S. Wells. "Manatee Behavioral Responses to Vessel Approaches: Results of Digital Logger Tagging of Manatees in Belize." Submitted to Marine Mammal Science. In review, 12/31/02.
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IV. Description of Proposed Scientific Research

A. Abstract

This permit application covers three research projects on a variety of marine mammals including endangered species in the North Atlantic, the Gulf of Mexico and the Mediterranean Sea. The primary research method involves tagging marine mammals with an advanced digital sound recording tag (DTAG) that can record the acoustic stimuli an animal hears, along with measuring vocal, behavioral, and physiological responses to sound. The first project to be conducted under this permit will study the baseline behavior of tagged animals. In the second project, tagged subjects will be exposed to specific sounds in a carefully controlled manner at received levels of 120-160 dB re 1 μ Pa rms for short sounds of a whalefinding sonar in the Mediterranean Sea. The third project studies the responses of tagged sperm whales to short impulses from airgun arrays at received levels no higher than 180 dB re 1 μ Pa rms will be studied in the Gulf of Mexico. Playbacks of natural coda vocalizations will be used as control stimuli for projects 2&3. The primary research objective of the airgun playbacks is to determine what characteristics of exposure to specific sounds evoke behavioral responses in marine mammals, an important issue for marine mammal conservation and for NMFS regulators. This research involves potential takes by harassment including close approaches for tagging, attachment of tags, focal follows, and playbacks of sound. When our tags are retrieved after release, small fragments of sloughed skin are often found in the suction cup. These will be exported from field sites for genetic analyses.

B. Summary of Marine Mammals or parts to be Taken, Imported, or Exported

1. Species Names, Population Groups and estimated age, sex and reproductive condition

a) Humpback whale (*Megaptera novaeangliae*)

Stocks: North Atlantic (including Gulf of Mexico)

b) Minke Whale (*Balaenoptera acutorostrata*)

Stocks: North Atlantic (including Gulf of Mexico), Mediterranean

c) Bryde's whale (*Balaenoptera edeni*)

Stocks: North Atlantic (including Gulf of Mexico)

d) Sei whale (*Balaenoptera borealis*)

Stocks: North Atlantic (including Gulf of Mexico)

e) Fin whale (*Balaenoptera physalus*)

Stocks: North Atlantic (including Gulf of Mexico), Mediterranean

f) Blue whale (*Balaenoptera musculus*)

Stocks: North Atlantic (including Gulf of Mexico)

g) Sperm whale (*Physeter macrocephalus*)

Stocks: North Atlantic (including Gulf of Mexico), Mediterranean

h) Beaked whales (*Mesoplodon spp.*)

Stocks: unknown stock structure. Locations: North Atlantic (including Gulf of Mexico), Mediterranean

i) Cuvier's beaked whale (*Ziphius cavirostris*)

Stocks: unknown stock structure. Locations: North Atlantic (including Gulf of Mexico), Mediterranean

j) Northern Bottlenose whale (*Hyperoodon ampullatus*)

Stocks: unknown stock structure. Locations: North Atlantic

k) Pilot whale (*Globicephala* spp.)

Stocks: unknown stock structure. Locations: North Atlantic (including Gulf of Mexico), Mediterranean

l) Bottlenose dolphin (*Tursiops truncatus*)

Stocks: North Atlantic excluding mid-Atlantic coastal stock (including Gulf of Mexico); Mediterranean

m) Common Dolphin (*Delphinus delphis* and *D. capensis*)

Stocks: North Atlantic (including Gulf of Mexico); Mediterranean

Most likely *D. delphis* in study sites, but *D. capensis* is a relatively newly differentiated species and these congeners may be difficult to differentiate sighting at sea.

n) Atlantic spotted dolphin (*Stenella frontalis*)

Stocks: North Atlantic (including Gulf of Mexico)

o) Pantropical spotted dolphins (*Stenella attenuata*)

Stocks: North Atlantic (including Gulf of Mexico)

p) Spinner dolphin (*Stenella longirostris*)

Stocks: North Atlantic (including Gulf of Mexico)

q) Clymene dolphin (*Stenella clymene*)

Stocks: North Atlantic (including Gulf of Mexico)

r) Striped dolphin (*Stenella coeruleoalba*)

Stocks: North Atlantic, Mediterranean

s) Rough-toothed dolphin (*Steno bredanensis*)

Stocks: North Atlantic (including Gulf of Mexico)

t) Fraser's dolphin (*Lagenodelphis hosei*)

Stocks: North Atlantic (including Gulf of Mexico)

u) Kogia spp. (*K. simus* and *breviceps*)

Stocks: North Atlantic (including Gulf of Mexico) and Mediterranean for both species (*K. simus* most likely for Mediterranean, but both species are seen in the N. Atlantic and too little is known to rule out which species; cannot easily be identified to species at sea)

v) Risso's dolphin (*Grampus griseus*)

Stocks: North Atlantic (including Gulf of Mexico); Mediterranean

w) Killer whale (*Orcinus orca*)

Stocks: North Atlantic (including Gulf of Mexico)

x) False killer whale (*Pseudorca crassidens*)

Stocks: North Atlantic (including Gulf of Mexico)

y) Melon-headed whale (*Peponocephala electra*)

Stocks: North Atlantic (including Gulf of Mexico)

z) Pygmy killer whale (*Feresa attenuata*)

Stocks: North Atlantic (including Gulf of Mexico)

2. Parts and Specimen Samples

Description: The only animal parts that would be taken in this research would be a by-product of tagging. If sloughed skin is visible on the suction cups when they are recovered after sliding off of the tagged animal, the skin samples will be collected from the tag attachment. Tissue will be used for molecular genetic analyses including determination of sex, population, matriline, and possibly paternity (Amos *et al.* 1992). Modern genetic analysis only requires very small samples, and any excess tissue will be made available to other investigators interested in stock analysis etc. Numbering: Date, time, location and animal's daily identification letter will be recorded with the skin sample, along with the name of the collector.

3. Status of the affected species/stocks:

a) Humpback whale (*Megaptera novaeangliae*)

The humpback whale is protected under both the ESA and the Marine Mammal Protection Act (MMPA). It is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2002). Humpback whales have a global distribution. The population under consideration in this project involves the North Atlantic, including the rare humpback that might be sighted in the Gulf of Mexico. Humpback whales in the North Atlantic have at least six feeding grounds, Gulf of Maine, Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway. Whales segregating to these different feeding grounds show some genetic differentiation, indicating that they may represent sub-populations (Palsbøll *et al.* 1995; Larsen *et al.* 1996). Whales from all six feeding areas may mix in the West Indies breeding grounds, although some N. Atlantic humpbacks winter in the Cape Verde Islands (Reiner *et al.*, 1996). This permit application treats humpbacks in the North Atlantic, including the Gulf of Mexico, as one stock. Notarbartolo di Sciara and Demma (1997) do list several strandings of humpback whales in the Mediterranean, but this species is so rare there that it is considered extralimital and it is exceedingly unlikely that one might be inadvertently exposed to playback there.

The best estimate of humpback numbers in the North Atlantic is based on survey data from the 1992 Years of the North Atlantic Humpback (YONAH) project that was a large-scale study of humpback whales throughout the North Atlantic. Waring *et al.* (1999) cite a best estimate of 10,600 humpback whales in the North Atlantic (95% CI 9,300–12,100). A different photographic mark-recapture analysis from these cruises gave an ocean-basin estimate of the north Atlantic population as 10,600 (Smith *et al.*, 1999). Waring *et al.* (2002) prefer an estimate of 11,570 from mark recapture analysis of the YONAH data. The population(s) of humpback whales in the North Atlantic appears to be increasing (Barlow and Clapham, 1997). Human impact may be slowing the increase of humpback whales in the western North Atlantic by interactions with fisheries and vessel collisions. Of the carcasses that were suitable for evaluation over the past seven years, 60% showed evidence of anthropogenic causes of death (30% from ship strikes, 25% with gear entanglement and 5% with evidence of both factors) (Wiley *et al.*, 1995). The mean annual mortality from fisheries is 2.8, while the total annual mortality is estimated to be 3.0, with most non-fisheries mortality stemming from vessel strikes (Waring *et al.*, 2002). Less is known about the size and potential human impacts on humpback whales in the eastern North Atlantic.

AUTEC (2000) and Carillo (N.D.) list humpback whales in their checklist of cetaceans sighted in Bahamian and Canarian waters, respectively, but the sighting probability is listed as low. Humpback whales have been sighted in the Gulf of Mexico (Jefferson and Shiro, 1997), but were not sighted enough for calculation of abundance by Davis et al. (2000). Würsig et al. (2000) report a 1997 sighting of a group of six humpbacks about 250 km east of the Mississippi Delta at a depth of 1000 m. They also report two strandings for the Gulf and note that humpback songs have been recorded in the northwestern part of the Gulf of Mexico. Humpback whales may be selected for tagging as part of project 1 in the North Atlantic and there is a very small chance that they may be inadvertently exposed to sound playbacks as part of project 3 in the Gulf of Mexico. Since humpback whales are viewed as extralimital in the Mediterranean, we do not expect any potential for playback takes in project 2.

b) Minke Whale (*Balaenoptera acutorostrata*)

Minke whales occur in all oceans. The minke whale is not listed as endangered under the Endangered Species Act, but it is protected under the Marine Mammal Protection Act. Four stocks have been described for the North Atlantic — Canadian east coast, west Greenland, central North Atlantic, and northeastern North Atlantic (Donovan, 1991). However, Donovan (1991) also quotes the following conclusion from the IWC scientific committee: “The evidence for dividing minke whales in the North Atlantic into different stocks is very scanty.” The IWC estimates a population size for the N Atlantic excluding the Canadian East Coast of approximately 149,000 (95% confidence estimates 120,000-182,000). The population size of the Canadian east coast is estimated to be at least 3,515, with a best estimate of 4018 (Waring et al., 2002). The potential biological removal is estimated at 35; less than 10% of this is taken annually in fisheries interaction. AUTEC (2000) list minke whales in their checklist of cetaceans sighted in Bahamian waters, but the sighting probability is listed as low. Minke whales have been sighted in the Gulf of Mexico (Jefferson and Shiro, 1997), but were not sighted enough for calculation of abundance by Davis et al. (2000). Notarbartolo di Sciara and Demma (1997) list minke whales as occasionally sighted in the Mediterranean. Minke whales may be selected for tagging in project 1 in the Mediterranean and/or North Atlantic and may be exposed to sound playbacks as part of the permitted research in project 2 in the Mediterranean. There is a small chance that they may be incidentally exposed to sound playback in the Gulf of Mexico as part of project 3.

c) Bryde’s whale (*Balaenoptera edeni*)

The distribution of Bryde’s whales is tropical, typically less than 35 degrees of latitude. Bryde’s whales are not listed as endangered under the Endangered Species Act. Bryde’s whale is the most common baleen whale in the Gulf of Mexico and is the only one routinely sighted there. Mullin and Hoggard (2000) report that Bryde’s whales are sighted in groups of up to seven in the Gulf of Mexico. Davis et al. (2000) did sight them often enough in the northern Gulf of Mexico to estimate an abundance of 35, but they were among the least commonly sighted species. Waring et al. (2002) estimate a minimum number of 17 Bryde’s whales in the northern Gulf of Mexico. Bryde’s whales are in the checklist for the Canary Islands (Carillo N.D.) and they might be sighted during tagging cruises in the western North Atlantic, so they may be tagged as part of project 1.

Bryde's whales are not in the checklist for the Mediterranean (Notarbartolo di Sciara and Demma, 1997). We are thus unlikely to expose Bryde's whales to playback nor have an opportunity to tag them as part of project two. We also list them as potentially exposed to playback here in the very unlikely event that one might unintentionally be exposed to playback in the Gulf of Mexico as part of project 3.

d) Sei Whale (*Balaenoptera borealis*)

All populations of sei whales seem to overwinter in warm temperate or sub-tropical waters, and have a pole-ward summer feeding migration. There is no evidence of any resident populations of sei whales. Sei whales did not receive international protection until 1970, when catch quotas for the North Pacific became species based. Complete protection was given in the North Pacific in 1976. Quotas were put into effect in the North Atlantic in 1977. All legal whaling for sei whales stopped when the moratorium on commercial whaling took effect in the Northern Hemisphere in 1986. Sei whales are protected both by the Endangered Species Act (ESA) and the Marine Mammal Protection Act. They are listed in CITES Appendix I (Reeves et al., 1998).

Donovan (1991) concludes that the stock identity of sei whales in the North Atlantic is an unresolved research question, but the International Whaling Commission did set catch limits for two "stocks," Nova Scotia and Iceland-Denmark Strait. For management purposes, the U.S. National Marine Fisheries Service recognizes a Nova Scotia stock of sei whales that extends from the continental shelf of the NE US to Newfoundland (Waring et al., 1999, 2002). This Nova Scotia stock of sei whales was estimated at 1400-2200 in the late sixties (Horwood, 1987), though little apparent effort has been made to assess this stock in the past 10 years. The current number of sei whales in the Nova Scotia stock is unknown. Because so little information is available about the stock, it is not possible to assess the current status of this stock. Less is known about the stock structure, population size and potential human impacts on sei whales in the Eastern North Atlantic. There have been no reported fisheries related mortality or serious injury to sei whales observed by NMFS from 1991-1997. There was one report in 1994 of a ship strike mortality from a sei whale carcass found on the bow of a container ship when it docked in Boston (Waring et al., 1999).

Sei whales are reported in the Carillo (N.D.) checklist for cetaceans in the Canary Islands, and they may be sighted along the eastern coast of the US during cruises for project 1. Sei whales are not reported for the Mediterranean (Notarbartolo di Sciara and Demma, 1997). Sei whales have been sighted in the Gulf of Mexico (Jefferson and Shiro, 1997), but were not sighted enough for calculation of abundance by Davis et al. (2000). Sei whales may be selected for tagging as part of project 1 of the permitted research. It is extremely improbable that they would be inadvertently exposed to playbacks in the Mediterranean, but we include them for project 3 in the unlikely case of incidental exposure in the Gulf of Mexico.

e) Fin Whale (*Balaenoptera physalus*)

The fin whale is protected under both the ESA and the Marine Mammal Protection Act (MMPA). It is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Reeves et al., 1998). Stocks of fin whales around the world were severely depleted by the whaling industry in the 18th-20th

centuries. Under the 1946 International Convention for the Regulation of Whaling, a minimum size limit of 55 ft was put in effect in the North Pacific. The International Whaling Commission (IWC) did not begin to manage commercial whaling for fin whales until 1969 in the North Pacific (Allen, 1980) and 1976 in the North Atlantic (Sigurjonsson, 1988). The fin whale was given full protection from Antarctic whaling in the 1976/1977 season, the North Pacific in the 1976 season, and the North Atlantic in the 1987 season.

The fin whale populations in the North Atlantic have been separated into several different stocks for management purposes: the Western North Atlantic (Waring et al., 1997), the British Isles-Spain-Portugal stock areas (Buckland et al., 1992a), and the East Greenland/Iceland Fin Whale population (Buckland et al., 1992b). The International Whaling Commission more finely divides North Atlantic fin whales into seven stock areas: Nova Scotia, Newfoundland-Labrador, West Greenland, East Greenland-Iceland, British Isles-Spain-Portugal, West Norway-Faroe Islands, and North Norway (Donovan, 1991). The fin whale population size for the Western North Atlantic has been estimated to be about 5000 (Hain et al., 1992) from a 1978-1982 survey (Reeves et al., 1998). The current best estimate is 2814 (Waring et al., 2002). The minimum population estimate stands at 2,362 (Waring et al., 2002). The East Greenland/Iceland Fin Whale population size has been estimated at 10,000 (95 % CI 7,600-14,200) individuals from 1987 and 1989 summer shipboard surveys (Buckland et al., 1992b). The number of Eastern Atlantic fin whales is estimated to be 17,000 (95% CI 10,400-28,900) for the British Isles-Spain-Portugal stock areas (Buckland et al., 1992a). All of these populations have high enough sizes and broad enough ranges, that the percentage of animals whose behavior might be slightly affected by unintentional exposure during playbacks would be very small. Fin whales have not been reported for the Bahamas (AUTC, 2000). Fin whales have been sighted in the Gulf of Mexico (Jefferson and Shiro, 1997), but were not sighted enough for calculation of abundance by Davis et al. (2000).

The Mediterranean Fin Whale population size based on a sighting survey in the summer of 1991 in the Western Mediterranean is estimated at 3,583 (SE: 967 95% CI: 2,130-6,027) (Forcada, 1996). The fin whale is the most common large cetacean in the Mediterranean. It is frequently reported in the Western Mediterranean (Gannier, 1998). During the summer months, the whales seem to congregate in the highly productive waters of the north-western basin. While finbacks are sighted in the eastern North Atlantic near the approaches to the Mediterranean (e.g. Canary Islands, Carillo N.D.), there is little evidence that the population of the Western Mediterranean migrates out to the Atlantic through the strait of Gibraltar; genetic differentiation of Mediterranean finbacks suggests that they may form at least a subpopulation (Bérubé et al., 1998).

The human factors affecting the growth of this population are best documented for the western North Atlantic and include mortality associated with fishing gear and vessel collision. Four stranded animals from 1992-1997 showed evidence of fishery interactions (Waring et al., 1999). Based on one observed entanglement mortality in Maine in 1994, the estimate of annual entanglement mortality in U.S. waters is 0.2 (Waring et al., 1999). Vessel collision is thought to be responsible for two mortalities, and seven other individuals bore evidence of vessel collision, though it was not conclusive whether or not these collisions were the cause of death. The Marine Mammal

Commission conducted a review suggesting that these estimates of vessel mortality may be too low (Laist et al., 2001).

Fin whales may be selected for tagging in project 1, and may be selected as subjects for playbacks in project 2. There is a slight chance that a rare finback in the Gulf of Mexico might incidentally be exposed to sound playbacks as part of project 3.

f) Blue whale (*Balaenoptera musculus*)

The blue whale is protected under both the ESA and the Marine Mammal Protection Act (MMPA). It is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2002). Blue whales were extensively hunted worldwide; in the North Atlantic, their numbers were so depleted that they remain rare in formerly important habitats in the northern and northeastern Atlantic (Sigurjónsson and Gunnlaugsson, 1990). Little is known about the population size for blue whales anywhere in the North Atlantic other than in the Gulf of St. Lawrence, where Sears et al. (1987) have identified over 300 individuals. By comparison, the International Whaling Commission estimates 460 blue whales for the entire southern oceans (95% confidence limits 210-1000). The U.S. National Marine Fisheries Service uses the Sears et al. (1987) data for estimating a minimum population size of 308 in the western North Atlantic (Waring et al., 2002). Davis et al. (2000) list blue whales in their checklist for the Gulf of Mexico, as two animals have been reported stranded, one in Texas and one in Louisiana (Würsig et al., 2000), but their own surveys did not sight any. Clark (1995) has acoustically detected calls of blue whales in the North Atlantic, especially near the Grand Banks of Newfoundland and west of the United Kingdom. Blue whales are listed in a checklist of cetaceans in the Canary Islands (Carillo N.D.). Sigurjónsson and Gunnlaugsson (1990) estimate that the blue whales sighted near Iceland appear to be increasing at a rate of 4.9%/year, and Waring et al. (1999) assume a maximum net productivity rate of 4%. Blue whales may be selected for tagging as part of project 1. It is unlikely that they would be inadvertently exposed to playbacks in the Mediterranean, where they are extralimital. They are rare in the Gulf of Mexico, but we will request two takes in the unlikely event that some might be present and incidentally exposed to playback.

g) Sperm whale (*Physeter macrocephalus*)

The sperm whale is protected under both the ESA and the Marine Mammal Protection Act (MMPA). It is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2002). The proposed research would involve sperm whales, *Physeter macrocephalus*, in the North Atlantic or in the Mediterranean. The research in the North Atlantic would include the Gulf of Mexico, an area which is thought not to represent a different stock from the western North Atlantic. Sperm whales are highly mobile – one sperm whale wounded in the Azores was taken off Denmark the next year (Reeves and Whitehead, 1997), and another Azorean sperm whale was taken by Icelandic whalers (Martin, 1982). Reeves and Whitehead (1997) suggest that while sperm whales show a clear pattern of geographical segregation of different social groupings, they may not have a well-defined subpopulation structure in ocean basins. The International Whaling Commission (Donovan, 1991) and the U.S. National Marine Fisheries Service (Waring et al., 1999) recognize the entire North Atlantic as one

stock area. The North Atlantic stock of sperm whales is estimated to be at least 3,505 animals with a best estimate of 4,702 animals according to the latest NMFS/NEFSC stock assessment (Waring et al., 2002), but this estimate just includes whales sighted off the eastern coast of the United States. The stock of sperm whales in the northern Gulf of Mexico is estimated to be at least 411 animals with a best estimate of 530 animals according to the latest NMFS/NEFSC stock assessment (Waring et al., 2002), but this estimate is based upon data from the early 1990s. Davis et al. (2000) also estimate a population of about 530 sperm whales in the oceanic northern Gulf of Mexico, where they tend to be sighted in waters of about 1000 m depth. Sightings in the oceanic northern Gulf of Mexico are concentrated south of the Mississippi delta.

Sperm whales were hunted as late as the 1970s in the North Atlantic, but they live far enough from shore that they are seldom impacted by human fisheries and are not known to be at great risk of vessel collision. Shifting focus from lethal or injurious takes to harassment, there are conflicting reports on whether sperm whales respond strongly to low to moderate exposures to manmade noise. Watkins et al. (1985) reported that sperm whales in the Windward Islands exposed to military sonars during the Grenada invasion, silenced, altered their activity patterns, and moved away. Watkins and Schevill (1975) report that sperm whales cease clicking when they hear sounds of pingers emitting one short pulse/sec when the source level is in the 110-130 dB re 1 μ Pa range. Sperm whales are also reported to react to sounds of seismic exploration at great ranges. Mate et al. (1994) report that sperm whales move as far as 50 km away after the onset of seismic surveys in the Gulf of Mexico. Bowles et al. (1994) report that sperm whales in the southern Indian Ocean sometimes ceased vocalizing when pulses from an airgun area 300+ km away were heard. In contrast, Madsen et al. (2002) report no cessation of vocalization for sperm whales exposed to seismic sounds up to 146 dB re 1 μ Pa pk-pk. Observers on or near seismic vessels also found little evidence of avoidance or disruption for sperm whales in the presence of seismic survey (Stone, 1997, 1998, 2000, 2001).

In the Mediterranean sperm whales are widely distributed from the Alboran Sea to the Levant Basin, mostly over steep slope and deep offshore waters. Sperm whales are rarely sighted in the Sicilian Channel, and are vagrant in the northern Adriatic and Aegean Seas (Notarbartolo di Sciara and Demma, 1997). In the Italian seas, sperm whales are found more frequently over the continental slope off western Liguria, western Sardinia, northern and eastern Sicily, and both coasts of Calabria. Little information is available either on the population size of Mediterranean sperm whales or on the population relationship between sperm whales in the Mediterranean and the North Atlantic. However, initial genetic information (Engelhaupt pers. comm.), the frequent observation of neonates in the Mediterranean, and the scarcity of sightings from the Gibraltar area (Bayed and Beaubrun, 1987) point to the possibility that sperm whales in the Mediterranean, like fin whales, may form a resident, reproductively isolated population. Sperm whales are sighted in the North Atlantic just outside of the Mediterranean, for example in the Canary Islands (Carillo N.D.).

Sperm whales have been known in the past to be a common cetacean species in Italian waters, as can be inferred, for example, from the wealth of sightings reported by Bolognari (1949). By contrast, when relative abundance data became available in the mid 1990s (Notarbartolo di Sciara *et al.*, 1993; Marini *et al.*, 1996), sighting frequencies of sperm whales were surprisingly low compared to other regular species, perhaps

indicating habitat degradation or extensive human induced mortality for sperm whales in Italian waters. Possible causes of this condition include the large number of accidental captures in high seas swordfish driftnets (Notarbartolo di Sciara, 1990), considered to be having a potential impact on the population (International Whaling Commission, 1994), and disturbance from intense marine traffic, including high-speed passenger vessels (hydrofoils). Environmental noise deriving from seismic surveys (using airgun arrays) and military operations involving active sonars is another source of concern (Notarbartolo di Sciara and Gordon, 1997).

Sperm whales in the Mediterranean and the North Atlantic (including the Gulf of Mexico) may be tagged for baseline observations in project 1. They will be tagged for testing a whalefinding sonar in the Mediterranean as part of project 2. They will also be the subjects of controlled exposure experiments of seismic sounds from an airgun array in the Gulf of Mexico as part of project 3.

h) Beaked whales (*Mesoplodon* spp)

Ziphiid species are difficult to identify at sea; therefore, most field identifications are made at the generic level at best (Mead, 1989b; Waring et al., 1999). Beaked whales known to inhabit the North Atlantic include *Hyperoodon ampullatus*, *Ziphius cavirostris*, and four species of *Mesoplodon*: *M. bidens*, *M. densirostris*, *M. europaeus*, and *M. mirus*. Data on stocks of all mesoplodont whales and *Ziphius* have been combined into a single category for “undifferentiated beaked whale” in NMFS U.S. Atlantic Marine Mammal Stock Assessments (Waring, et al., 1999, 2002; NOAA NMFS 2000). However, our experience studying *Ziphius* in the Ligurian Sea and sightings of *Mesoplodon* sp. in Bahamian waters, lead us to be relatively confident of our ability to distinguish these genera during follows. Any skin samples recovered from the tags will be analyzed after the tagging to provide species, sex, and stock identification. The bottlenose whale can often be identified to species at sea and will therefore be treated separately in the section after *Ziphius*.

Stock structure for all mesoplodonts in the North Atlantic is unknown. Most data on the distribution of species are obtained principally from stranding records; however, sightings data have also been obtained from NMFS survey cruises in the western North Atlantic near Georges Bank and in the Gulf Stream (Mead, 1989b; Smithsonian Institution cetacean distributional database, unpublished data, 1999; Waring et al., 1999). *M. bidens* have been reported from New England waters to the ice pack, and along the Newfoundland coast in the summer. Both *M. densirostris* and *M. europaeus* tend to be distributed in tropical to warm-temperate waters, and have been reported from the Gulf of Mexico, Caribbean, and Florida with northernmost strandings for each species occurring off Nova Scotia and Massachusetts, respectively. Stranding records for *M. mirus* range from the Bahamas to Nova Scotia, and it is considered to be a temperate water species.

Mesoplodonts are also reported from the eastern North Atlantic. Reiner et al. (1993) report strandings of *M. europaeus* and *Z. cavirostris* in the Azores Islands, and *M. bidens* is sighted there. In the Canaries Islands, *M. densirostris* and *M. europaeus* have been sighted, and there is one stranding record for *M. mirus* (Carillo N.D.).

The beaked whales reported in the Mediterranean include *Ziphius cavirostris* and *Mesoplodon densirostris*. Little is known about the abundance of either species in the Mediterranean. Both species are also known from the North Atlantic, and it is not known

the whether the populations of these beaked whale species are isolated for these two areas.

The total number of *Mesoplodon* spp. and *Ziphius* in the North Atlantic is unknown, and it is impossible to determine the minimum population estimate of either taxon (Waring et al., 1999). The best estimate of abundance for the undifferentiated beaked whales including *Mesoplodon* spp. and *Ziphius* off the east coast of North America is 3,196 (CV = 0.34) from data obtained during NMFS line transect surveys conducted during July to September, 1995 (Waring et al., 2002). These surveys provided the most thorough coverage to date of known deep-water habitats preferred by beaked whales. The minimum population estimate for undifferentiated beaked whales is 2419 (CV = 0.34); however, neither estimate includes a correction factor for submerged animals (Waring, et al., 2002). There are insufficient data to determine population trends, and current and maximum net productivity rates are unknown. Potential Biological Removal (PBR) for the undifferentiated beaked whale complex in 1999 was estimated at 8.9; the total average estimated annual fishery-related mortality of beaked whales in the U.S. Exclusive Economic Zone (EEZ) for 1992 - 1996 was 9.7 (CV = 0.07) (Waring et al., 1999). This raised concern about the effect of this fishery mortality, and the pelagic drift net fishery most involved in the takes was closed. The current estimate for PBR is 24, and the closure of the pelagic drift net fishery has reduced this fishery mortality (Waring et al. 2002).

The status of both mesoplodont beaked whales and *Ziphius* relative to the optimum sustainable population in the U.S. Atlantic EEZ is unknown (Waring et al., 1999). Neither group is listed as threatened or endangered under the Endangered Species Act. PBR cannot be determined at the species level; however, the total fishery mortality and serious injury for this group was judged in 1999 to exceed the calculated PBR, thus it could not be considered to be insignificant and approaching zero mortality and serious injury rate for undifferentiated beaked whales (Waring et al., 1999). Because of uncertainty regarding stock size and evidence of fishery-related mortality and serious injury, both *Ziphius* and *Mesoplodon* spp. were considered to be a strategic stock by NMFS (Waring et al., 1999). The closure of the pelagic drift net fishery has reduced this fishery mortality and current estimates of PBR have raised to 23. However, in addition to the fisheries mortality, there is increasing evidence that unusual mass strandings of beaked whales are related to naval maneuvers involving sonars (Evans and England 2001). The extent of mortality and injury caused by this is unknown. Similar strandings are reported for beaked whales in the Mediterranean (Frantzis, 1998; D'Amico, 1998) and eastern North Atlantic (Simmonds and Lopez-Jurado, 1991). The most recent stock assessment for these beaked whales (Waring et al. 2002) considers them to be a strategic stock "because of uncertainty regarding stock size and evidence of human induced mortality and serious injury associated with acoustic activities."

Beaked whales of the genus *Mesoplodon* may be tagged to study baseline behavior as part of project 1. Because of their evident special sensitivity to sound, they will not be subjects for playback experiments in projects 2 and 3, and every effort will be made not to incidentally expose them to playback sounds.

i) Cuvier's beaked whale (*Ziphius cavirostris*)

Heyning (1989) suggests that Cuvier's beaked whale, *Ziphius cavirostris*, may have the widest distribution of any beaked whale. Wursig et al. (2000) suggest that the distribution of *Ziphius* is limited to between 60 deg N and 50 deg S. Strandings of *Ziphius* near the E coast of the US have occurred from Nova Scotia to Florida, Gulf of Mexico, and the Caribbean, with sightings primarily occurring along the continental shelf edge in the mid-Atlantic. The beaked whales reported in the Mediterranean include *Ziphius cavirostris*, but little is known about the abundance of this species in the Mediterranean. This species is also known from the North Atlantic, and it is not known whether the populations of this beaked whale species are isolated for these two areas. Cuvier's beaked whale is present in the Gulf of Mexico, with an estimated abundance in the oceanic northern Gulf of Mexico of 159 animals (Davis et al. 2000). Waring et al. (2002) use older sighting data from 1991-1994 to estimate a minimum population size of 20 Cuvier's beaked whale in the northern Gulf of Mexico, with a best estimate of 30 whales. This estimate is probably quite low, because it was limited to sightings where it was possible to identify to species, which is quite difficult for these whales. Mullin and Hoggard (2000) report that *Ziphius* tend to be sighted along the deep continental slope at depths of about 2000 m in groups of 1-4. See the section above for information on population status that combines *Ziphius* with other "unidentified beaked whales."

There has been growing concern that beaked whales in general and *Ziphius* in particular may be particularly sensitive to intense sounds from midfrequency sonars (Evans and England 2001). There is growing evidence for a correlation between mass strandings of beaked whales including *Ziphius* and *Mesoplodon* sp. with naval maneuvers involving surface warships that have mid-frequency sonar systems (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; D'Amico, 1998). The most recent stock assessment for these beaked whales (Waring et al. 2002) considers them to be a strategic stock "because of uncertainty regarding stock size and evidence of human induced mortality and serious injury associated with acoustic activities." Some of the research covered by project 1 involves studying the distribution, behavior, and vocalizations of beaked whales in order to better understand factors that might lead to their sensitivity, and to better be able to detect them. However, in light of their potential vulnerability, the proposed research plans for playbacks or transmission of sounds in projects 2 and 3 will be carried out away from areas where *Ziphius* is known to occur.

j) Northern Bottlenose whale (*Hyperoodon ampullatus*)

The northern bottlenose whale tends to be sighted in temperate or polar waters. In the western North Atlantic, a resident population has been studied for more than a decade by Hal Whitehead and his group at Dalhousie University. This population is regularly sighted in a submarine canyon called the "Gully" offshore of Sable Island. Bottlenose whales also have been sighted in continental slope waters off the east coast of the US. In the eastern North Atlantic, bottlenose whales are most frequently sighted or stranded in the winter along the Atlantic coasts of W. Europe. In the summer, they appear to tend to move to the Norwegian and Greenland Seas, but they are also range farther south, for they are included in the checklist of cetacean species prepared for the Azores by Reiner et al. (1993). Bottlenose whales in the eastern North Atlantic were intensively hunted from the 1880s to the 1920s and then again from 1945-1960s. These stocks may be depleted,

although they have not been subject of intensive whaling for over 30 years. Bottlenose whales may be tagged in the North Atlantic for project 1.

k) Pilot whales (*Globicephala* spp.)

Long-finned pilot whales, *Globicephala melas*, and short-finned pilot whales, *Globicephala macrorhynchus*, are difficult to identify to the species level at sea. Due to this identification difficulty, stock status for the individual species is problematic in the North Atlantic, therefore many references to stock assessment refer to *Globicephala* sp., lumping the two congeners. The International Whaling Commission estimates the number of pilot whales in the Central and Eastern North Atlantic at 780,000 (95% confidence intervals 440,000-1,370,000). *G. melas* tends to have a more northerly distribution than *G. macrorhynchus* in U.S. waters with some overlap, but both tend to occur along the shelf edge and Gulf Stream (Payne and Heinemann, 1993). Current NMFS Stock assessments estimate a minimum size for the genus in the Western North Atlantic of 11,343, with a best estimate of 14,524 (Waring et al. 2002). *G. macrorhynchus* is also found on the continental shelf and slope of the northern Gulf of Mexico (Mullin et al., 1991). Davis et al. (2000) estimate an abundance of 1,471 for *G. macrorhynchus* in the northern Gulf of Mexico. *G. macrorhynchus* is listed as having a moderate sighting rate in the Bahamas Islands (AUTC 2000). *G. melas* is sighted in the northwestern Mediterranean, but is not common there (Gannier, 1998). While pilot whales are not listed as endangered under the U.S. Endangered Species Act, they are a strategic stock in the western North Atlantic because the estimated average annual fishery-related mortality to pilot whales, *Globicephala* sp., exceeds the calculated PBR (Waring et al., 1999, 2002). The primary threat to these animals continues to be fishery by-catch (Fairfield et al., 1993; Johnson et al., 1999). Switching from lethal or injurious takes to potential for behavioral disruption, pilot whales in the Mediterranean have been reported to react to military sonars (Rendell and Gordon, 1999). In the Mediterranean and North Atlantic, we would tag pilot whales as part of project 1 for the purpose of learning more about their diving and acoustic behavior. Relatively little is known about the lives of these animals in the wild, although studies of stomach contents (Gannon et al., 1997) and correlative studies of acoustics and behavior (Weilgart and Whitehead, 1990) suggest a unique ecology. If we encounter and are able to tag pilot whales in the Mediterranean, as part of project 2 we may test the ability of the whalefinder sonar to detect them and monitor for responses of the sort noted by Rendell and Gordon (1999). While we do not plan playback experiments with pilot whales as subjects in the Gulf of Mexico, it is possible that they may be inadvertently exposed to some during the airgun playbacks to sperm whales in the Gulf of Mexico as part of project 3.

Pelagic dolphins

- l) Bottlenose dolphin (*Tursiops truncatus*)
- m) Common Dolphin (*Delphinus delphis* and *D. capensis*)
- n) Atlantic spotted dolphin (*Stenella frontalis*)
- o) Pantropical spotted dolphin (*Stenella attenuata*)
- p) Spinner dolphin (*Stenella longirostris*)
- q) Clymene dolphin (*Stenella clymene*)
- r) Striped dolphin, (*Stenella coeruleoalba*)
- s) Rough-toothed dolphin (*Steno bredanensis*).
- t) Fraser's dolphin (*Lagenodelphis hosei*)

Most of the study animals in this permit are large cetaceans thought to be sensitive to low frequency noise. However, there is some evidence that pelagic dolphins may be sensitive to higher frequency components of pervasive manmade broadband noises such as air guns (Goold and Fish, 1998). There are also some loud noise sources, such as sonars used for depth sounding and fish finding etc. that operate in higher frequency regions where dolphins are more sensitive. This suggests the potential importance of controlled studies of the impact of noise on pelagic delphinids. We would propose to tag pelagic dolphins for project 1 on an opportunistic basis for the purpose of learning more about their diving and acoustic behavior. We also hope to tag delphinids in the Mediterranean as part of project 2 in order to study active mid or high frequency sonars designed to detect marine mammals. The most likely species for this would be *Tursiops truncatus* or *Stenella coeruleoalba*. While we would not select dolphins as playback subjects for project 3 in the Gulf of Mexico, it is possible that species present there could be incidentally exposed to playbacks.

The following information on stock sizes from the western North Atlantic comes from (Waring *et al.*, 1999, 2002). Species data from the Gulf of Mexico from comes Waring *et al.* (1997, 2002):

Species	Population estimate (minimum)	Productivity rates	PBR	Annual human-caused mortality/ serious injury	Stock status
<i>Tursiops truncatus</i> (offshore)	13,453 (8,794) ¹ 20642 ² 43,233 ⁴	0.04*	88 ¹ 206 ² 432 ⁴	10 ¹ 5.3 ² 2.8 ⁴	Non-strategic
<i>Delphinus delphis</i>	22,215 (16,060) ¹ 11,142 ² 23,655 ⁴	0.04*	154 ¹ 107 ² 227 ⁴	780 ¹ 612 ² 375 ⁴	Strategic
<i>Stenella frontalis</i>	4,772 (1,617) ¹ 23,699 ² 27,785 ⁴	0.04*	16 ¹ 236 ² 278 ⁴	9.9 ¹ 7.8 ^{2,4}	Non-strategic
<i>Stenella attenuata</i>	8450 ²	0.04*	84 ²	7.8 ² 1 ⁴	Non-strategic
<i>Stenella</i>	11,251 ³			0.31 ⁴	Non-

<i>longirostris</i>					strategic
<i>Stenella clymene</i> <i>N Gulf of Mex</i>	10,093 ³ 4,120 ⁴		41 ⁴	0 ⁴	Non-strategic
<i>Stenella coeruleoalba</i>	31,669 (18,220) ¹ 44,500 ²	0.04*	182 ¹ 445 ²	10.7 ¹ 7.3 ³	Non-strategic
<i>Steno bredanensis</i> <i>N Gulf of Mex</i>	852 (660) ³	0.04*	6.6 ³	0 ³	Non-strategic
<i>Lagenodelphis hosei</i> <i>N Gulf of Mex</i>	127 ³ 66 ⁴		0.7 ⁴	0 ⁴	Non-strategic
Species	Population estimate (minimum)	Productivity rates	PBR	Annual human-caused mortality/serious injury	Stock status

Table 1. Stock population estimates and status for the Western North Atlantic and/or Gulf of Mexico. ¹ Information from (Waring *et al.*, 1999). ² Information from (NOAA NMFS, 2000). ³ Information about these species is for the northern Gulf of Mexico as reported in Waring *et al.* (1997). ⁴ Information from (Waring *et al.*, 2002). * The reproductive rates for these species are unknown, so a 4% figure is used for calculations of PBR and stock assessment maximum theoretical reproductive rate based on the constraints of reproductive life history (Barlow *et al.* 1995).

Given the relatively large population sizes in these species (Waring *et al.*, 1999, 2002), the little we know about their ecology, and the very low impact of our non-invasive tag, as part of project 1 we would like to attach tags on an opportunistic basis to delphinids such as *Stenella coeruleoalba*, *T. truncatus*, or *Delphinus delphis* in the Mediterranean. We also would like to test the ability of the whalefinder sonar to detect these animals as part of project 2. The following species are reported by Davis *et al.* (2000) as sighted in the Gulf of Mexico: *T. truncatus*, *Stenella attenuata*, *Stenella clymene*, *Stenella frontalis*, *Stenella coeruleoalba*, *Stenella longirostris*, *Steno bredanensis*, and *Lagenodelphis hosei*. Since these species are present in the Gulf of Mexico study site, they could be inadvertently exposed to playbacks directed at sperm whales in project 3.

Common dolphins occur in tropical and temperate oceans around the world. Two species of common dolphins, *D. delphinus* and *D. capensis*, have only recently been distinguished. The short-beaked common dolphin occurs from Iceland and Newfoundland southward along the coast of the United States (Würsig *et al.* 2000), while the long-beaked common dolphin occurs in coastal waters from Venezuela to Argentina (Perrin 2002). Neither of these species has been identified in the Gulf of Mexico, but given their distribution, either could occur there.

Little is known about the precise stock structure of dolphins in the Mediterranean and North Atlantic. However, we propose to work opportunistically with the most common species with large population sizes. Gannier (1998) indicates that the striped

dolphin *Stenella coeruleoalba* is by far the most common cetacean in the northwestern Mediterranean, accounting for 64% of sightings.

Our research will take us to the areas inhabited by different assemblages of these species in the North Atlantic, Gulf of Mexico, and Mediterranean, and the basic biological questions that the DTAG data can address for baseline data as part of project 1 will add to our limited knowledge of these species while having no deleterious effects on individuals. We propose tagging and playback experiments to delphinids in the Mediterranean as part of project 2. In addition, when we playback sounds to sperm whales in the Gulf of Mexico for project 3, other common delphinid species may appear in the area. Since they may incidentally be exposed to a playback directed towards sperm whales in this area, we request permission for potential harassment takes by these playbacks.

u) *Kogia* spp.

Due to the difficulty of accurately differentiating between *Kogia simus* and *K. breviceps* at sea, the population estimates are combined for the two species in the North Atlantic. Little is known about the population structure of *Kogia* in the North Atlantic. The best population estimates are for the western North Atlantic region. The best population estimate for the two species combined is 536 animals in the western North Atlantic, with a minimum estimate of 373 (Waring et al., 2002). Waring et al. (2002) list northern Gulf of Mexico stocks for the dwarf sperm whale *Kogia simus* and the pygmy sperm whale *Kogia breviceps*. Average abundance for *Kogia* spp. was cited as 547 (CV=0.28) (Hansen et al. 1995). Davis et al. (2000) estimate the abundance for *Kogia* spp in the northern Gulf of Mexico as 733. Due to the inability to differentiate species at sea, the population trends are unknown, the minimum population estimates for each of the two species are not available, and consequently PBR cannot be calculated for either species. Fortunately the annual human-related mortality is low for both species in both regions. Estimated annual human induced mortality for *K. breviceps* in the western North Atlantic is 6 animals, 0 for *K. simus* in the same area, and 0 for both species in the Gulf of Mexico (Waring et al., 2002). Due to these low human induced mortality rates, only the population of *Kogia breviceps* in the western North Atlantic is listed as strategic (Waring et al., 2002). Little is known about the distribution, abundance, or human impacts on *Kogia* in the Mediterranean. One *K. simus* is reported to have stranded along the Tuscan coast. AUTECH (2000) reports a moderate sighting rate for *K. breviceps* in the Bahamas Islands. *Kogia* are reported for the Canary Islands (Carillo N.D.), and there is one report of their stranding along with beaked whales (Simmonds and Lopez-Jurado, 1991) in association with naval maneuvers. Relatively little is known about the behavior of these species, and tagging would provide both acoustic and behavioral data to augment what little is known about them. *Kogia* may be tagged opportunistically as part of project 1. Because of their potential sensitivity to sound, as indicated by their co-stranding with *Ziphius* during naval maneuvers, they will not be selected as playback subjects in either projects 2 or 3. However, they may be inadvertently exposed to playback of the whalefinder sonar as part of project 2 in the Mediterranean, or to airgun sounds as part of project 3 in the Gulf of Mexico.

v) Risso's dolphin (*Grampus griseus*)

This species is regularly sighted in both the Mediterranean and Gulf of Mexico regions (Gannier, 1998, Davis et al., 2000). The best estimate of abundance of Risso's dolphin is for the western north Atlantic region, and the minimum estimate is 22,916 (CV=0.29) (Waring et al. 2002). Davis et al. (2000) estimate the abundance of *Grampus* in the oceanic northern Gulf of Mexico at 3,040. Waring et al. (2002) give a best estimate of 2,749 for *Grampus* in the northern Gulf of Mexico, with a minimum estimate of 2199. Waring et al. (2002) review data on fisheries mortality in the western north Atlantic. The total fishery mortality for this stock, 51, is < 10% of the calculated Potential Biological Removal for this population, which is 220. The status of the stock is unknown and there are not enough data to establish a trend in population size. The PBR estimated for the northern Gulf of Mexico stock is 22, and the annual fisheries mortality is 19. Because the human induced mortality does not exceed PBR these are not considered a strategic stocks. However, the fishery related mortality of Risso's dolphins in the northern Gulf of Mexico is close to the PBR, and this requires careful attention. Relatively little is known about the behavior of this species, and tagging would provide both acoustic and behavioral data to augment what little is known about the distribution of Risso's dolphins. Risso's dolphins (*Grampus griseus*) may be tagged opportunistically in the Mediterranean and North Atlantic as part of project 1. Risso's dolphins may be selected as subjects for tests of the whalefinder sonar in the Mediterranean as part of project 2. *Grampus* may be unintentionally exposed to playback of airgun sounds in the Gulf of Mexico as part of project 3. Any exposure of Risso's dolphins to playback would likely involve only a small number of animals and a tiny percentage of even local populations.

w) Killer whale (*Orcinus orca*)

Little is known about the population size of killer whales (*Orcinus orca*) in the North Atlantic. The 1998 - 2002 NOAA U.S. Atlantic marine mammal stock assessment reports indicate that the population size for killer whales in the U.S. Atlantic coastal waters is unknown. AUTC (2000) estimates a very low sighting rate for killer whales in the Bahamas Islands, but they have been sighted there. Killer whales are sighted in the Canary Islands in the eastern North Atlantic (Carillo N.D.). Notarbartolo di Sciara and Demma (1997) list killer whales as occasionally sighted in the Mediterranean. Davis et al. (2000) estimate an abundance of 277 killer whales in the northern Gulf of Mexico. Waring et al. (2002) give a best estimate of 277 killer whales in the northern Gulf of Mexico and a minimum estimate of 197. The status of the stock is unknown and there are not enough data to establish a trend in population size. The PBR for this stock is estimated at 2, and there is no known human induced mortality. Killer whales may be tagged in the Mediterranean and North Atlantic as part of project 1. Killer whales may be tagged and subjects for the project 2 tests of the whalefinder sonar in the Mediterranean. Killer whales may be incidentally exposed to playback of airgun sounds in the Gulf of Mexico as part of project 3. Any exposure of killer whales to playback would likely involve only a small number of animals and a tiny percentage of even local populations.

x) False killer whale (*Pseudorca crassidens*)

The false killer whale (*Pseudorca crassidens*) has a global distribution in warm temperate and tropical waters. False killer whales are not known to occur in dense

concentrations and the population structure is not well known. AUTECH (2000) reports a very low sighting rate of false killer whales in waters near the Bahamas Islands. *Pseudorca* is sighted in the Canary Islands (Carillo N.D.). Notarbartolo di Sciara and Demma (1997) list false killer whales as occasionally sighted in the Mediterranean. *Pseudorca* is also sighted in the Gulf of Mexico, and Davis et al. (2000) estimate an abundance of 817 in the northern Gulf of Mexico. Waring et al. (2002) give a best estimate for the population size of *Pseudorca* in the northern Gulf of Mexico of 381, with a minimum estimate of 236. The status of the stock is unknown and there are not enough data to establish a trend in population size. The PBR for this population is set at 2.4, and there is no known human induced mortality. This is therefore not considered a strategic stock. False killer whales may be tagged in the Mediterranean and North Atlantic as part of project 1. False killer whales may be tagged and subjects for tests in project 2 of the whalefinder sonar in the Mediterranean. False killer whales may be unintentionally exposed to playback of airgun sounds in the Gulf of Mexico as part of project 3. Any exposure of false killer whales to playback would likely involve only a small number of animals and a tiny percentage of even local populations.

y) Melon-headed whale (*Peponocephala electra*)

The Melon-headed whale is widely distributed in pelagic tropical waters. It is relatively common in the Gulf of Mexico. Davis et al. (2000) estimate a population of 3,965 for the oceanic northern Gulf of Mexico, the section of the Gulf where our research is focused. Waring et al. (2002) give a best estimate for population size of 3965, and a minimum estimate of 2888. The status of the stock is unknown and there are not enough data to establish a trend in population size. The PBR in the northern Gulf of Mexico is 29, but since there are no known human induced mortalities, this is not considered a strategic stock (Waring et al 2002). Melon-headed whales are also sighted in Bahamian waters (AUTECH 2000) and are likely to occur in tropical waters of the North Atlantic, but little is known about the distribution and abundance. Melon-headed whales may be tagged in the North Atlantic as part of project 1. Melon-headed whales may be unintentionally exposed to playback of airgun sounds in the Gulf of Mexico as part of project 3.

z) Pygmy killer whale (*Feresa attenuata*)

The pygmy killer whale is widely distributed in subtropical and tropical waters. It can be difficult to differentiate from melon-headed whales under normal survey sighting conditions. It has been sighted in the Gulf of Mexico. Waring et al. (2002) give a best estimate for population size of 518, and a minimum estimate of 285. The status of the stock is unknown and there are not enough data to establish a trend in population size. The PBR in the northern Gulf of Mexico is 2.8, but since there are no known human induced mortalities, this is not considered a strategic stock (Waring et al 2002). Würsig et al. (2000) state that *Feresa* are sighted from the Carolinas to Texas and the West Indies in the western North Atlantic, and they have been sighted in the Gulf off Texas and in the west-central portion of the northern Gulf, in water 500-1000 m deep. Pygmy killer whales may be tagged in the North Atlantic as part of project 1. Pygmy whales may be unintentionally exposed to playback of airgun sounds in the Gulf of Mexico as part of project 3.

C. Detailed Description of the Proposed Research Activity

1. Duration of the project and locations of taking:

Table 2. Duration and locations of all 3 proposed research projects. North Atlantic location includes the Gulf of Mexico.

Species	Dates of proposed research	Location of proposed research	Ports of entry/export
Humpback whale (<i>Megaptera novaeangliae</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
Minke whale (<i>Balaenoptera acutorostrata</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Bryde's whale (<i>Balaenoptera edeni</i>)	5/03-5/08	North Atlantic	US, Canary Islands
Sei whale (<i>Balaenoptera borealis</i>)	5/03-5/08	North Atlantic	US, Canary Islands
Fin whale (<i>Balaenoptera physalus</i>)	5/03-5/08	North Atlantic	US, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Blue whale (<i>Balaenoptera musculus</i>)	5/03-5/08	North Atlantic	US, Canary Islands
Sperm whale (<i>Physeter macrocephalus</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Beaked whales (<i>Mesoplodon</i> spp.)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Bottlenose whale (<i>Hyperoodon ampullatus</i>)	5/03-5/08	North Atlantic	US, Canada
Pilot whale (<i>Globicephala</i> spp.)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Bottlenose dolphin (excluding mid-Atlantic coastal stock) (<i>Tursiops truncatus</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Common dolphin (<i>Delphinus delphis</i> and <i>D. capensis</i>)	5/03-5/08	North Atlantic	US, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Atlantic spotted dolphin (<i>Stenella frontalis</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
Pantropical spotted dolphin (<i>Stenella attenuata</i>)	5/03-5/08	North Atlantic	US, Bahamas

Spinner dolphin (<i>Stenella longirostris</i>)	5/03-5/08	North Atlantic	US
Clymene dolphin (<i>Stenella clymene</i>)	5/03-5/08	North Atlantic	US
Striped dolphin (<i>Stenella coeruleoalba</i>)	5/03-5/08	North Atlantic	US, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Rough-toothed dolphin (<i>Steno bredanensis</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Fraser's dolphin (<i>Lagenodelphis hosei</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
Kogia spp. (<i>K. simus</i> and <i>breviceps</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Risso's dolphin (<i>Grampus griseus</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Killer whale (<i>Orcinus orca</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
False killer whale (<i>Pseudorca crassidens</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
Melon-headed whale (<i>Peponocephala electra</i>)	5/03-5/08	North Atlantic	US, Bahamas
Pygmy killer whale (<i>Feresa attenuata</i>)	5/03-5/08	North Atlantic	US, Bahamas

Table 3. Duration and locations of proposed research project #1 using Dtags to monitor baseline behavior of tagged whales. This project involves no playbacks or controlled exposures of sound transmissions.

PROJECT #1			
SPECIES	DATES OF PROPOSED RESEARCH	LOCATION OF PROPOSED RESEARCH	PORTS OF ENTRY/EXPORT
Humpback whale (<i>Megaptera novaeangliae</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
Minke whale (<i>Balaenoptera acutorostrata</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Bryde's whale (<i>Balaenoptera edeni</i>)	5/03-5/08	North Atlantic	US, Canary Islands
Sei whale (<i>Balaenoptera borealis</i>)	5/03-5/08	North Atlantic	US, Canary Islands
Fin whale (<i>Balaenoptera physalus</i>)	5/03-5/08	North Atlantic	US, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Blue whale (<i>Balaenoptera musculus</i>)	5/03-5/08	North Atlantic	US

Sperm whale (<i>Physeter macrocephalus</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Beaked whales (<i>Mesoplodon</i> spp.)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Bottlenose whale (<i>Hyperoodon ampullatus</i>)	5/03-5/08	North Atlantic	US
Pilot whale (<i>Globicephala</i> spp.)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Bottlenose dolphin (excluding mid-Atlantic coastal stock) (<i>Tursiops truncatus</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Common dolphin (<i>Delphinus delphis</i> or <i>D. capensis</i>)	5/03-5/08	North Atlantic	US
	5/03-5/08	Mediterranean	La Spezia
Atlantic spotted dolphin (<i>Stenella frontalis</i>)	5/03-5/08	North Atlantic	US, Bahamas
Pantropical spotted dolphin (<i>Stenella attenuata</i>)	5/03-5/08	North Atlantic	US, Bahamas
Spinner dolphin (<i>Stenella longirostris</i>)	5/03-5/08	North Atlantic	US
Clymene dolphin (<i>Stenella clymene</i>)	5/03-5/08	North Atlantic	US
Striped dolphin (<i>Stenella coeruleoalba</i>)	5/03-5/08	North Atlantic	US
	5/03-5/08	Mediterranean	La Spezia
Rough-toothed dolphin (<i>Steno bredanensis</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Fraser's dolphin (<i>Lagenodelphis hosei</i>)	5/03-5/08	North Atlantic	US, Bahamas
Kogia spp. (<i>K. simus</i> and <i>breviceps</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Risso's dolphin (<i>Grampus griseus</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Killer whale (<i>Orcinus orca</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
False killer whale (<i>Pseudorca crassidens</i>)	5/03-5/08	North Atlantic	US, Bahamas, Canary Islands
	5/03-5/08	Mediterranean	La Spezia
Melon-headed whale (<i>Peponocephala electra</i>)	5/03-5/08	North Atlantic	US, Bahamas

Pygmy killer whale (<i>Feresa attenuata</i>)	5/03-5/08	North Atlantic	US, Bahamas
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Table 4. Duration and locations of proposed research project #2 testing a whalefinding sonar in the Mediterranean Sea. This table only lists potential subjects for whalefinder tests. Beaked whales of the genera *Ziphius* and *Mesoplodon* also occur in this area, but no playbacks will occur in areas where *Ziphius* are sighted, and every effort will be made to avoid exposure to these species.

PROJECT #2			
SPECIES	DATES OF PROPOSED RESEARCH	LOCATION OF PROPOSED RESEARCH	PORTS OF ENTRY/EXPORT
Minke whale (<i>Balaenoptera acutorostrata</i>)	5/03-5/08	Mediterranean	La Spezia
Fin whale (<i>Balaenoptera physalus</i>)	5/03-5/08	Mediterranean	La Spezia
Sperm whale (<i>Physeter macrocephalus</i>)	5/03-5/08	Mediterranean	La Spezia
Pilot whale (<i>Globicephala</i> spp.)	5/03-5/08	Mediterranean	La Spezia
Bottlenose dolphin (<i>Tursiops truncatus</i>)	5/03-5/08	Mediterranean	La Spezia
Short-beaked Common dolphin (<i>Delphinus delphis</i>)	5/03-5/08	Mediterranean	La Spezia
Striped dolphin (<i>Stenella coeruleoalba</i>)	5/03-5/08	Mediterranean	La Spezia
Rough-toothed dolphin (<i>Steno bredanensis</i>)	5/03-5/08	Mediterranean	La Spezia
Kogia spp. (<i>K. simus</i> and <i>breviceps</i>)	5/03-5/08	Mediterranean	La Spezia
Risso's dolphin (<i>Grampus griseus</i>)	5/03-5/08	Mediterranean	La Spezia
Killer whale (<i>Orcinus orca</i>)	5/03-5/08	Mediterranean	La Spezia
False killer whale (<i>Pseudorca crassidens</i>)	5/03-5/08	Mediterranean	La Spezia

Table 5. Locations and durations of proposed research project #3 in the Gulf of Mexico testing responses of sperm whales to sounds of airguns used for seismic survey. All species other than sperm whales are listed here for incidental harassment takes resulting from exposure to an airgun playback directed at sperm whales.

PROJECT #3

SPECIES	DATES OF PROPOSED RESEARCH	LOCATION OF PROPOSED RESEARCH	PORTS OF ENTRY/EXPORT
Humpback whale (<i>Megaptera novaeangliae</i>)	5/03-5/08	Gulf of Mexico	
Minke whale (<i>Balaenoptera acutorostrata</i>)	5/03-5/08	Gulf of Mexico	
Bryde's whale (<i>Balaenoptera edeni</i>)	5/03-5/08	Gulf of Mexico	
Sei whale (<i>Balaenoptera borealis</i>)	5/03-5/08	Gulf of Mexico	
Fin whale (<i>Balaenoptera physalus</i>)	5/03-5/08	Gulf of Mexico	
Blue whale (<i>Balaenoptera musculus</i>)	5/03-5/08	Gulf of Mexico	
Sperm whale (<i>Physeter macrocephalus</i>)	5/03-5/08	Gulf of Mexico	US
Beaked whales (<i>Mesoplodon</i> spp.)	5/03-5/08	Gulf of Mexico	
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	5/03-5/08	Gulf of Mexico	
Pilot whale (<i>Globicephala</i> spp.)	5/03-5/08	Gulf of Mexico	
Bottlenose dolphin (<i>Tursiops truncatus</i>)	5/03-5/08	Gulf of Mexico	
Common dolphin (<i>Delphinus delphis</i> or <i>D. capensis</i>)	5/03-5/08	Gulf of Mexico	
Atlantic spotted dolphin (<i>Stenella frontalis</i>)	5/03-5/08	Gulf of Mexico	
Pantropical spotted dolphin (<i>Stenella attenuata</i>)	5/03-5/08	Gulf of Mexico	
Spinner dolphin (<i>Stenella longirostris</i>)	5/03-5/08	Gulf of Mexico	
Clymene dolphin (<i>Stenella clymene</i>)	5/03-5/08	Gulf of Mexico	
Striped dolphin (<i>Stenella coeruleoalba</i>)	5/03-5/08	Gulf of Mexico	
Rough-toothed dolphin (<i>Steno bredanensis</i>)	5/03-5/08	Gulf of Mexico	
Fraser's dolphin (<i>Lagenodelphis hosei</i>)	5/03-5/08	Gulf of Mexico	
Kogia spp. (<i>K. simus</i> and <i>breviceps</i>)	5/03-5/08	Gulf of Mexico	
Risso's dolphin (<i>Grampus griseus</i>)	5/03-5/08	Gulf of Mexico	
Killer whale (<i>Orcinus orca</i>)	5/03-5/08	Gulf of Mexico	
False killer whale (<i>Pseudorca crassidens</i>)	5/03-5/08	Gulf of Mexico	

Melon-headed whale (<i>Peponocephala electra</i>)	5/03-5/08	Gulf of Mexico	
Pygmy killer whale (<i>Feresa attenuata</i>)	5/03-5/08	Gulf of Mexico	

2. Types of Taking Involved and Estimate of Numbers of Animals that may be Taken:

Description of activities

Close approach (CA) – A close approach is defined as any approach to a single focal animal or one of several animals within a group within 10-15 m to allow for tag attachment and/or photo-identification. Following the recommendations of the NMFS Permit Office, we will request permission for and report all approaches within this range, even though we see no sign of behavioral disruption during many such approaches. One reason for such an extremely conservative approach is that the environmental assessment is based in part upon the requested number of takes. If this is higher than expected, then the analysis will be particularly conservative. Another reason for the conservative approach is that a goal of this research is to define situations associated with disruption of behavior. It is appropriate that this permit authorize any potential takes, because subtle signs of disruption of behavior may be found in post-cruise analyses.

TAG – Attachment of the digital archival recording tag to a single focal animal via suction cup. The NMFS definition of a tagging take is that the tag touches the whale. It takes several of these touches for what we would consider a successful tag attachment. Sometimes when the tag touches the whale, there is no obvious reaction. Once a tag has been attached the whale may show a startle reaction for a second, roll or turn away and speed up, or slap the tail, but these reactions seldom last more than several seconds. The only reaction to tagging we have observed that may have a longer effect is for the whale to start a dive soon after the tag attachment. Sperm whales often surface for several minutes blowing many times before a long dive. If they dive earlier after tagging than they otherwise would have, the next foraging dive involves normal diving and foraging behavior but may be shorter than before or after.

Focal Follow (FF) – Following a single focal animal (typically the tagged animal) or several whales in a group including the focal animal during the tagging to relate data on the tag to observed surface behaviors. Sometimes focal follows can be conducted on individuals using natural markings, and behavioral data from this kind of follow can be useful, but the majority of focal follows in the permitted research will use the tag to facilitate the follow. Since a radio transmitter on the tag broadcasts the bearing to the whale everytime the tagged whale surfaces, and since the tag itself is visible, it is possible to follow tagged whales from standoff distances considerably farther than non-tagged whales. Where possible, the focal follow may include time before the tag is attached and after the tag releases from the animal to determine any effects of tagging on behavior. These focal follows are typically conducted from 100-500 m from the animal, depending on weather conditions and visibility from the platform. When bigeye binoculars can be used from a ship, focal follows can be performed from considerably farther away, often 1-2 km. The focal follow is conducted with a goal of not affecting the behavior of the focal animal at all, and we seldom have detected any sign of behavioral disruption.

However, following recommendations of the NMFS Permit Office, we request permission for, and report all follows, whether or not behavioral disruption was observed, because this is a setting in which it is possible that it might occur. This overestimate makes analyses of possible impact very conservative.

Playbacks (PB) – The playback experiments will use an underwater sound projector (underwater loudspeaker, also called the sound source) deployed from a vessel. The vessel-based playbacks may involve a stationary source of sound, or the source vessel may slowly approach the subject. The received level at the whale subject will be limited to less than a maximum sound exposure level, which will be set below levels that might cause injury. We propose a maximum sound exposure level or received level at the whale of 160 dB re 1 μ Pa rms for the whalefinder sonar signals used in project 2 and 180 dB re 1 μ Pa rms for the sounds of airguns used in project 3. The source level of these playbacks will be carefully controlled to limit the received level at the whale. Before starting each playback, we will estimate range to the whale subject and adjust the source level to achieve a specified received level at the whale. For specific protocols for projects 2 and 3, see the detailed descriptions in IVC3. The basic protocol of the playbacks involves a series of experiments, starting at a low exposure level, and only increasing exposure after no disruption of behavior has been observed at the lower level. If disruption of behavior is observed at one exposure level, responses at that exposure will be carefully studied before exposure is changed. This design minimizes the exposure necessary to define the relationship between exposure and possible responses.

a) Estimating the number of animals that may be taken by unintentional harassment during the course of the research activity:

Some of these animals are often sighted in groups. For these species, when we make a close approach for tagging one whale, other animals nearby may show minor behavioral changes. Similarly when we conduct a focal follow of an animal in a group, we will often be about the same distance from most animals within the group, and there would be a potential for disrupting the behavior of the surrounding animals as well as the focal animal. Therefore for these species, we request a larger number of CA and FF takes than tagging takes. This increase in the estimated number of takes, likely overestimated, makes the environmental analyses of this research permit more conservative. Group size for cetaceans at sea is often estimated as all of the animals that can be sighted together. For estimating close approach or focal follow takes, we feel that it is more appropriate to consider smaller subgroups and we propose only to count animals surfacing within a few body lengths of the focal animal. In our experience, when we approach a sperm whale for tagging, it is often closely accompanied by 1-2 other whales. Little is known about group size in *Kogia*; we will apply the same rule of thumb as for sperm whales. Therefore we estimate that a close approach of one individual for each attachment attempt to sperm whales and *Kogia* sp. may also require counting incidental approaches to two other animals that may be near by. Therefore in order to estimate the potential number of CA and FF takes for these species we will multiply the number of tagging attempts by three times. For estimating the potential number of focal follow takes, we only count successful tag attachment attempts, while for close approach we must count all attempts, successful and unsuccessful. In our research on Cuvier's beaked whale in the Mediterranean, we have conducted a focal follow on a group that changed over time, but

reached a maximum of 7 animals. However, the usual number of animals sighted at any one time is less than 3. Therefore we estimate that a close approach of one individual for each attachment attempt to beaked whales of the genera *Ziphius*, *Hyperoodon*, and *Mesoplodon* may also require counting incidental approaches to two other animals that may be nearby. Therefore in order to estimate the potential number of CA and FF takes for these species we will multiply the number of tagging attempts by three times. For estimating the potential number of focal follow takes, we only count successful tag attachment attempts, while for close approach we must count all attempts, successful and unsuccessful. The dolphins we propose to tag may often be bow riding, and this is likely to be the context for attempting to tag dolphins in which the largest number of animals would be near the tagging vessel. We anticipate fewer than 10 animals bow riding at the time of a tag attachment attempt. Similarly even though dolphins may be sighted in large groups, any potential impacts of a focal follow of a tagged animal are likely to be limited to animals quite close to the tagged animal. Therefore in order to estimate the potential number of CA and FF takes for these species we will multiply the number of tagging attempts by ten times. For estimating the potential number of focal follow takes, we only count successful tag attachment attempts, while for close approach we must count all attempts, successful and unsuccessful. This is a very conservative number, as bowriding, while clearly involving a response to the vessel, is usually not considered to involve a harassment take.

The subject of each playback experiment is the tagged animal(s), but animals other than the tagged ones may also be exposed to the playbacks. This project will help to determine the thresholds for disturbance to these animals, and will help to estimate what kinds of exposures elicit what kinds of behavioral reactions. For the purposes of estimating number of incidental harassment takes for this permit, we will report all animals in the group of the study subject as potential harassment takes during these playback experiments. Sperm whales are often sighted in groups of 10-20 individuals. We will multiply the number of sperm and baleen whales to be tagged by 20 to estimate the likely number of possible playback takes. The group size for pelagic dolphins varies by species and location. For example, striped dolphins may be sighted in groups numbering in the thousands (Leatherwood et al., 1983). We would not conduct a playback to such a large group. For project 2 we are proposing playbacks to dolphins in the northwest Mediterranean, where group size of striped dolphins averages 18.5 (Gannier, 1998). The other dolphin species sighted in this area (*Tursiops* and *Delphinus*) occur in smaller groups. In order to have a conservative accounting group size, we will multiply the number of dolphins to be tagged by 100 to estimate the likely number of possible playback takes. This is much larger than the group sizes we are actually likely to encounter, so overestimates the take. Following instruction from the NMFS Permit Office, each stage of estimating potential takes is overestimated for several reasons. This overestimation reduces the probability that the permit limits the research from achieving its goals. Since some of the research covered in this permit application is specifically designed to detect and measure behavioral disruption, and since the relationship between exposure and response is not completely understood, it is also important that the estimated number of takes leave room should unanticipated subtle responses be detected in post-cruise analyses.

In some of the areas where this research is proposed, individuals of other marine mammal species may be present. A major goal of the proposed research is to help define acoustic criteria that cause changes in behavior that may be considered takes by harassment. In the absence of such data, we propose to follow current NMFS practice and report all marine mammals or sea turtles sighted within a range from the source vessel during playback where the received level is predicted to be 160 dB or more (rms) in a tally of animals that might be used to estimate potential unintentional harassment takes (NMFS 2003). For playbacks under project 2 in the Mediterranean, we propose to conduct playbacks to most cetacean species present except for the genus *Kogia* and beaked whales of the species *Ziphius cavirostris* and *Mesoplodon densirostris*. In order to cover the possibility of unintentional exposure during playback, we request potential takes by harassment of any of these species (*Kogia*, *Ziphius cavirostris* and *Mesoplodon densirostris*) that may be present in the area. The maximum range out to 160 dB is only 316 m for this sound source. We will avoid known *Ziphius* habitat, monitor carefully for these species, and shutdown if any are sighted at any range from the source vessel. The odds of any incidental harassment takes for these species in project 2 is as low as we can make it, probably about the same as the risk of the source vessel colliding with a whale. Therefore, the estimates of incidental harassment takes for these species, while lower than for some of the other species, are likely very overestimated. For project 3 in the Gulf of Mexico, we propose to conduct playbacks on sperm whales, but we may also sight other species during the playback. In order to cover the possibility of this unintentional exposure during playback, potential takes by harassment are requested for species that may be present in the area, including, humpback whale (*Megaptera novaeangliae*), blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), Bryde's whale (*Balaenoptera edeni*), minke whale (*Balaenoptera acutorostrata*), sei whale (*Balaenoptera borealis*), beaked whales (*Mesoplodon* spp., and *Ziphius cavirostris*), pilot whales (*Globicephala* spp.), *Tursiops truncatus*, *Delphinus delphis*, *Stenella frontalis*, *Stenella attenuata*, *Stenella coeruleoalba*, *Stenella longirostris*, *Stenella clymene*, *Steno bredanensis*, *Kogia* spp., *Grampus griseus*, *Orcinus orca*, *Lagenodelphis hosei*, *Peponocephala electra*, *Feresa attenuata*, and *Pseudorca crassidens*.

Table 6. List of number of takes of each type combining all three research projects covered under this permit.

A	B	C	D	E	F	G	H	I
Species	Goal for # animals successfully tagged annually	Max Annual # tagging takes	Repeat Takes?	Max Annual # close approach takes	Max Annual # focal follow takes	Goal # Playbacks	Max Annual # playback takes	Location
Humpback whale (<i>Megaptera novaeangliae</i>)	20	30	<=3/day /indiv	135	90	N/A	12 incidental	North Atlantic (including Med and Gulf of Mexico)
Minke whale (<i>Balaenoptera acutorostrata</i>)	40	60	<=3/day /indiv	270	180	20	400 2 incidental	North Atlantic (including Med and Gulf of Mexico)
Bryde's whale (<i>Balaenoptera edeni</i>)	20	30	<=3/day /indiv	135	90	N/A	12 incidental	North Atlantic (including Med and Gulf of Mexico)

Sei whale (<i>Balaenoptera borealis</i>)	20	30	<=3/day /indiv	135	90	N/A	2 incidental	North Atlantic (including Med and Gulf of Mexico)
Fin whale (<i>Balaenoptera physalus</i>)	40	60	<=3/day /indiv	270	180	20	400 2 incidental	North Atlantic (including Med and Gulf of Mexico)
Blue whale (<i>Balaenoptera musculus</i>)	20	30	<=3/day /indiv	135	90	N/A	2 incidental	North Atlantic (including Med and Gulf of Mexico)
Sperm whale (<i>Physeter macrocephalus</i>)	100	250	<=3/day /indiv	2250	750	40	800	North Atlantic (including Med and Gulf of Mexico)
Beaked whales (<i>Mesoplodon</i> spp.)	20	100	<=3/day /indiv	1200	300	N/A	800 incidental	North Atlantic (including Med and Gulf of Mexico)
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	20	100	<=3/day /indiv	1200	300	N/A	400 incidental	North Atlantic (including Med and Gulf of Mexico)
Bottlenose whale (<i>Hyperoodon ampullatus</i>)	20	100	<=3/day /indiv	1200	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Pilot whales (<i>Globicephala</i> spp.)	40	200	<=3/day /indiv	4000	2000	20	2000 2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Bottlenose dolphin (excluding mid-Atlantic coastal stock) (<i>Tursiops truncatus</i>)	40	200	<=3/day /indiv	4000	2000	20	2000 2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Common dolphin (<i>Delphinus delphis</i> and <i>D. capensis</i>)	40	200	<=3/day /indiv	4000	2000	20	2000 2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Atlantic spotted dolphin (<i>Stenella frontalis</i>)	20	100	<=3/day /indiv	2000	1000	0	2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Pantropical spotted dolphin (<i>Stenella attenuata</i>)	20	100	<=3/day /indiv	2000	1000	0	2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Striped dolphin (<i>Stenella coeruleoalba</i>)	40	200	<=3/day /indiv	4000	2000	20	2000 2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Spinner dolphin (<i>Stenella longirostris</i>)	20	100	<=3/day /indiv	2000	1000	0	2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Clymene dolphin (<i>Stenella clymene</i>)	20	100	<=3/day /indiv	2000	1000	0	2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Rough-toothed dolphin (<i>Steno bredanensis</i>)	40	200	<=3/day /indiv	4000	2000	20	2000 2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Fraser's dolphin (<i>Lagenodelphis hosei</i>)	20	100	<=3/day /indiv	2000	1000	0	2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Kogia spp. (<i>K. simus</i> and <i>K. breviceps</i>)	20	100	<=3/day /indiv	1200	300	0	800 incidental	North Atlantic (including Med and Gulf of Mexico)
Risso's dolphin (<i>Grampus griseus</i>)	40	200	<=3/day /indiv	4000	2000	20	2000 2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Killer whale (<i>Orcinus orca</i>)	40	200	<=3/day /indiv	4000	2000	20	2000 2000 incidental	North Atlantic (including Med and Gulf of Mexico)
False Killer whale (<i>Pseudorca crassidens</i>)	40	200	<=3/day /indiv	4000	2000	20	2000 2000 incidental	North Atlantic (including Med and Gulf of Mexico)

Melon-headed whale (<i>Peponocephala electra</i>)	20	100	<=3/day /indiv	2000	1000	0	2000 incidental	North Atlantic (including Med and Gulf of Mexico)
Pygmy killer whale (<i>Feresa attenuata</i>)	20	100	<=3/day /indiv	2000	1000	0	2000 incidental	North Atlantic (including Med and Gulf of Mexico)
A	B	C	D	E	F	G	H	I
Species	Goal for # animals successfully tagged annually	Max Annual # tagging takes	Repeat Takes	Max Annual # close approach takes	Max Annual # focal follow takes	Goal # Playbacks	Max Annual # playback takes	Location

Explanation of columns

Column B: Goal for # animals successfully tagged: This is the maximum number of individuals of the species we would want to tag in a year. The text just after these tables describes in detail how these goals were set for each project. Table 6 sums the annual numbers for all three projects covered under this permit application. The subsequent tables breakout the annual number of takes requested for each of the three individual projects covered under this permit application.

Column C: Max Annual Number of Tagging Takes: This number is larger than the tagging goal in column B because not every tagging take yields the data we need for a successful tagging. The NMFS Permit Office counts as a tagging take every time any part of the tag touches a whale. The probability that a tag will stay on the whale once it has touched depends upon the species, and the duration of attachment that we need for success depends upon the project as well. Table 10 shows how the Maximum Annual Number of Tagging Takes is calculated from this information, and Appendix 1 shows the actual calculations for each species.

Column D: Repeat Takes: This column is only included in Table 6, not in the subsequent Tables. It describes the number of times per day that tagging attempts are allowed for a particular individual. Up to three repeat tagging attempts are allowed per individual. Even if we have not attempted to tag an individual for the maximum allowable number of times, if the animal shows an adverse reaction, we will stop attempting to tag it. We consider a close approach to comprise a tagging attempt even if the tag does not touch the whale. Every attempt will be made not to approach or tag the same individual on different days. We make an effort to identify natural markings of every individual for which tagging is attempted. Usually it is relatively easy to recognize if one approaches the same whale within a day or so. It is possible that the same individual might have repeat takes at a longer interval, but analysis of photoidentification records from previous years of tagging similar species with similar tags under different permits suggest a low probability of repeated tagging of the same individual across different days or years for the species worked with this far. If playbacks are performed several times within a general area, or if an individual moves from one playback site to another one, reliable identification of all

exposed animals may not be possible in real time, leading to the possibility of multiple exposures of individuals to the playbacks.

Column E: Maximum Annual Number of Close Approach Takes: This number is larger than the Maximum Annual Number of Tagging Takes because some close approaches are required for photo-identification etc, and because the tagging team is not able to touch a tag to the whale on every approach. Sometimes the whale may dive or move away. If the tagging team feels that the whale is showing any negative reaction to the approach, they also stop the approach. The probability that a close approach will lead to the tag touching the whale depends upon the species. In addition, in most species, an animal selected for tagging may surface close enough to other individuals that a close approach to the selected animal requires the tagging vessel to also approach relatively closely to these other individuals. This number of close companions also varies by species. These close companions are also counted as incidental close approaches. Table 10 shows how the Maximum Annual Number of Close Approaches required for tagging is calculated from this information. At each stage we make conservative estimates that lead our estimated number takes to be higher than we are actually likely to find in the field. This estimate is not an estimate of expected harassment. Following advice from the NMFS Permit Office, we count and report every close approach because it represents a situation with a potential for harassment. It is not common for a close approach of animals not selected for tagging to result in any behavioral responses, especially for the animals such as delphinids, where the number of close companions is potentially large enough for the maximum number of close approaches to be large. This overestimate of the number of takes makes the environmental assessments for the permitted research more conservative.

Column F: Max Annual Number of Focal Follow Takes: Focal follow refers to our protocol of following an individual whale from a vessel. It is sometimes possible to follow an individual using natural markings, but most of the focal follows under the permitted research involve following the tagged whale until the tag falls off. We often try to follow a focal whale selected for tagging before and after the tag falls off as well. Our goal in these follows is for the observation vessel(s) not to affect the behavior of the whales at all. Since the tag gathers detailed behavioral data and gives a radio signal whenever the tagged whale surfaces, we can follow the whale at greater ranges than those required for close visual observations without the tag. The way we calculate the maximum annual number of animals involved in focal follow involves multiplying the number of tagging takes by the estimated number of animals likely to be found with the tagged individual. We use the same number of animals near the focal as is estimated for the close approaches. Our goal is to have no animals harassed by the focal follow, and we have seldom detected any responses at all. However, we count and report every animal involved in the focal follows because it represents a situation with a potential for harassment. Given the expectation that few, if any, animals will be harassed by focal follow, the estimated numbers may seem unreasonably high. However, this overestimation makes the environmental analyses of the permitted research particularly conservative. In addition, one of the goals of these studies is to detect and report any disruption of behavior. The conservative process for estimating large numbers of

potential takes ensures that even the most subtle behavioral changes, potentially discovered well after the field work, would be covered by this permit. Note that the same whale may be counted once as a close approach, tagging, and focal follow take. Thus it is incorrect to add up all the takes as if that represented the number of animals taken.

Column G: Goal Number of Playbacks: The annual goal number of playbacks is determined by a combination of the total number of experiments needed for a whole series of playbacks, and of the way in which playbacks are staged in sets of increasing exposure. The planned length and number of cruises per year also affects the annual goals. We plan a specific series of experiments that focus on sperm whales. This leads to a higher sample size for this species – up to 40 / year. For most other species, we propose a maximum annual goal number of 20 playbacks. There is no chance that the number of playbacks we actually perform will be anywhere close to the total requested across all species. During cruises in the Mediterranean for project 2, we will focus particularly on sperm whales, but it will be very useful to study other species in the area. It is difficult to predict which species will be most available, so in order to take advantage of opportunities in the field, we request for each the total tagging opportunities per cruise. This also covers for potential incidental takes during playbacks to other species in the Mediterranean.

Column H: Maximum Annual Number of Playback Takes: The maximum number of playback takes is larger than the goal number of playback experiments for two reasons. Some animals may be incidentally exposed to playbacks in the course of an experiment directed at another species. In addition, most of the species covered by this application are social. Any playback directed at one or a few tagged members of a group are likely to lead other members of the group to be exposed as well. In the Gulf of Mexico, we have found that we can simultaneously tag several sperm whales, and one playback to these animals yields more than one playback subject per playback experiment. Since sound travels well underwater, more animals could potentially be affected by playback than by the close approaches for tagging. Therefore the group size used to estimate playback takes (shown in Table 11) is larger than the size used to estimate close approach takes. Given the expectation that few animals farther away than the focal animal will be harassed by focal follow, the estimated numbers may seem unreasonably high. However, one of the goals of these studies is to detect and report any disruption of behavior. The conservative process for estimating large numbers of potential takes ensures that even the most subtle behavioral changes, potentially discovered well after the field work, would be covered by this permit.

Table 7. List of takes from project 1 involving tagging whales to monitor baseline behavior. No playbacks will be conducted.

Project 1 Takes. Column Letters match those of Table 6; col D Repeat Takes is not used here							
A	B	C	E	F	G	H	I
Species	Goal for # animals success-fully tagged annually	Max Annual # tagging takes	Max Annual # close approach takes	Max Annual # focal follow takes	Goal # Playbacks	Max Annual # playback takes	Location
Humpback whale (<i>Megaptera novaeangliae</i>)	20	30	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Minke whale (<i>Balaenoptera acutorostrata</i>)	20	30	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Bryde's whale (<i>Balaenoptera edeni</i>)	20	30	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Sei whale (<i>Balaenoptera borealis</i>)	20	30	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Fin whale (<i>Balaenoptera physalus</i>)	20	30	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Blue whale (<i>Balaenoptera musculus</i>)	20	30	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Sperm whale (<i>Physeter macrocephalus</i>)	40	100	900	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Beaked whales (<i>Mesoplodon</i> spp.)	20	100	1200	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	20	100	1200	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Bottlenose whale (<i>Hyperoodon ampullatus</i>)	20	100	1200	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Pilot whales (<i>Globicephala</i> spp.)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Bottlenose dolphin (excluding mid-Atlantic coastal stock) (<i>Tursiops truncatus</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Common dolphin (<i>Delphinus delphis</i> and <i>D. capensis</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Atlantic spotted dolphin (<i>Stenella frontalis</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Pantropical spotted dolphin (<i>Stenella attenuata</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Striped dolphin (<i>Stenella coeruleoalba</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Spinner dolphin (<i>Stenella longirostris</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)

Clymene dolphin (<i>Stenella clymene</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Rough-toothed dolphin (<i>Steno bredanensis</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Fraser's dolphin (<i>Lagenodelphis hosei</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Kogia spp. (<i>K. simus</i> and <i>K. breviceps</i>)	20	100	1200	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Risso's dolphin (<i>Grampus griseus</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Killer whale (<i>Orcinus orca</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
False Killer whale (<i>Pseudorca crassidens</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Melon-headed whale (<i>Peponocephala electra</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Pygmy killer whale (<i>Feresa attenuata</i>)	20	100	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Species	Goal for # animals success-fully tagged annually	Max Annual # tagging takes	Max Annual # close approach takes	Max Annual # focal follow takes	Goal # Playbacks	Max Annual # playback takes	Location

Table 8. List of takes requested for project 2 testing whalefinding sonars and sperm whale coda playbacks with cetaceans in the Mediterranean Sea.

Project 2 Takes. Column Letters match those of Table 6; col D Repeat Takes is not used here							
A	B	C	E	F	G	H	I
Species	Goal for # animals success-fully tagged annually	Max Annual # tagging takes	Max Annual # close approach takes	Max Annual # focal follow takes	Goal # Playbacks	Max Annual # playback takes	Location
Minke whale (<i>Balaenoptera acutorostrata</i>)	20	30	135	90	20	400	Mediterranean
Fin whale (<i>Balaenoptera physalus</i>)	20	30	135	90	20	400	Mediterranean
Sperm whale (<i>Physeter macrocephalus</i>)	20	50	450	150	20	400	Mediterranean
Beaked whales (<i>Mesoplodon</i> spp.)	0	0	0	0	0	400 incidental	Mediterranean
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	0	0	0	0	0	200 incidental	Mediterranean
Pilot whales (<i>Globicephala</i> spp.)	20	100	2000	1000	20	2000	Mediterranean
Bottlenose dolphin (<i>Tursiops truncatus</i>)	20	100	2000	1000	20	2000	Mediterranean
Common dolphin (<i>Delphinus delphis</i>)	20	100	2000	1000	20	2000	Mediterranean

Striped dolphin (<i>Stenella coeruleoalba</i>)	20	100	2000	1000	20	2000	Mediterranean
Rough-toothed dolphin (<i>Steno bredanensis</i>)	20	100	2000	1000	20	2000	Mediterranean
Kogia spp. (<i>K. simus</i> and <i>K. breviceps</i>)	0	0	0	0	0	400 incidental	Mediterranean
Risso's dolphin (<i>Grampus griseus</i>)	20	100	2000	1000	20	2000	Mediterranean
Killer whale (<i>Orcinus orca</i>)	20	100	2000	1000	20	2000	Mediterranean
False Killer whale (<i>Pseudorca crassidens</i>)	20	100	2000	1000	20	2000	Mediterranean
Species	Goal for # animals success-fully tagged annually	Max Annual # tagging takes	Max Annual # close approach takes	Max Annual # focal follow takes	Goal # Playbacks	Max Annual # playback takes	Location

Males and females of all species may be tagged, with the exception of calves
 All sex and age classes of a species may be exposed to playback sounds

Table 9. List of takes requested for project 3 in the Gulf of Mexico studying responses of tagged sperm whales to controlled exposures or playbacks of sounds of airguns used for seismic exploration. The only species for which this study is directed is the sperm whale. However, we list other species present in the Gulf because of the potential for incidental takes by harassment.

Project 3 Takes. Column Letters match those of Table 6; col D Repeat Takes is not used here							
A	B	C	E	F	G	H	I
Species	Goal for # animals success-fully tagged annually	Max Annual # tagging takes	Max Annual # close approach takes	Max Annual # focal follow takes	Goal # Playbacks	Max Annual # playback takes	Location
Humpback whale (<i>Megaptera novaeangliae</i>)	N/A	0	0	0	0	12 incidental	Gulf of Mexico
Minke whale (<i>Balaenoptera acutorostrata</i>)	N/A	0	0	0	0	2 incidental	Gulf of Mexico
Bryde's whale (<i>Balaenoptera edeni</i>)	N/A	0	0	0	0	12 incidental	Gulf of Mexico
Sei whale (<i>Balaenoptera borealis</i>)	N/A	0	0	0	0	2 incidental	Gulf of Mexico
Fin whale (<i>Balaenoptera physalus</i>)	N/A	0	0	0	0	2 incidental	Gulf of Mexico
Blue whale (<i>Balaenoptera musculus</i>)	N/A	0	0	0	0	2 incidental	Gulf of Mexico
Sperm whale (<i>Physeter macrocephalus</i>)	40	100	900	300	20	400	Gulf of Mexico
Beaked whales (<i>Mesoplodon</i> spp.)	N/A	0	0	0	0	400 incidental	Gulf of Mexico
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	N/A	0	0	0	0	200 incidental	Gulf of Mexico
Pilot whales (<i>Globicephala</i> spp.)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Bottlenose dolphin (<i>Tursiops truncatus</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico

Common dolphin (<i>Delphinus delphis</i> and <i>D. capensis</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Atlantic spotted dolphin (<i>Stenella frontalis</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Pantropical spotted dolphin (<i>Stenella attenuata</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Striped dolphin (<i>Stenella coeruleoalba</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Spinner dolphin (<i>Stenella longirostris</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Clymene dolphin (<i>Stenella clymene</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Rough-toothed dolphin (<i>Steno bredanensis</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Fraser's dolphin (<i>Lagenodelphis hosei</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Kogia spp. (<i>K. simus</i> and <i>K. breviceps</i>)	N/A	0	0	0	0	400 incidental	Gulf of Mexico
Risso's dolphin (<i>Grampus griseus</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Killer whale (<i>Orcinus orca</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
False Killer whale (<i>Pseudorca crassidens</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Melon-headed whale (<i>Peponocephala electra</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Pygmy killer whale (<i>Feresa attenuata</i>)	N/A	0	0	0	0	2000 incidental	Gulf of Mexico
Species	Goal for # animals success-fully tagged annually	Max Annual # tagging takes	Max Annual # close approach takes	Max Annual # focal follow takes	Goal # Playbacks	Max Annual # playback takes	Location

Males and females of all species may be tagged, with the exception of calves
All sex and age classes of a species may be exposed to playback sounds

Justification of proposed sample size for each type of take:

For all experiments, the driving sample size is the required sample size of tagged or focal animals. This derives in part from the goal for playback experiments. For sperm whales, we would hope to tag up to 20 individuals/year for playback experiments for project 2 and up to 40/year for project 3. For project 2 we propose playbacks to all other species in the Mediterranean other than *Kogia* or beaked whales of the genera *Ziphius* and *Mesoplodon*. For these other species in project 2 (not sperm whales, *Kogia*, or beaked whales of the genera *Ziphius* and *Mesoplodon*), we would anticipate tagging no more than 20 individuals for playbacks each year. The research in project 1 of this permit application just involves tagging of animals with no playback. There are three different goals for project 1, but one of these relates to the number of playbacks. For those species that will be involved in playbacks in projects 2&3, we wish to obtain baseline data from enough control animals that are tagged but not exposed to playback in order to have a sample size of control animals about the same as each kind of playback. This suggests a goal for project 1 of about 40 control samples for sperm whale, 20 from each species of

projects 2 and 3, and up to 20 for every other species. We are unlikely to conduct more than 20 playbacks total per cruise, so we are very unlikely to meet this goal for each species during the 2-4 week cruises planned for the field work in projects 2 and 3. However, we are requesting the full sample size for each species in project 2 to be able to take full advantage of field opportunities, depending upon what animals we encounter.

The goals of project one are threefold. The Dtag provides continuous unbiased and fine-grained sampling of vocal and motor behavior to an unprecedented level. Data from each set of deployments on a new species have opened up whole new areas for study. For example, once we had tagged 10 sperm whales, we discovered that one adult male fed not in the water column, but within a meter of the seafloor. Once we had tagged several tens of sperm whales, we had a large enough sample size to note several whales bottom feeding, including whales that would feed in the water column and the bottom on the same dive. If presented the opportunity in the field, this example shows how useful it is to tag up to 20 individuals of a species per cruise. Baseline tagging also provides data critical for the National Marine Fisheries Service and others to correct their visual sighting data by a correction factor derived from the dive, surfacing, and blow patterns of the species. This effort requires a variety of age/sex classes to be tagged, in case their diving behavior varies systematically, and demands a large enough sample size to accurately estimate variation in dive behavior. This will benefit from well more than 20 animals of a species to be tagged, but our plan is to tag up to about 20 animals of each species per cruise, and to broaden the sampling of the population by conducting this kind of tagging on a series of cruises. The third goal of this project is to provide another control for playback experiments. Each playback is designed so that responses of each subject can be compared to its own pre-exposure behavior. However, it is also useful to verify that the pre-exposure behavior is representative of baseline, and this can best be done with about the same number of baseline animals tagged as are involved in the controlled exposure experiments.

The number of estimated takes derives from the number of attempts required to tag and the number of animals that may be taken intentionally and incidentally during each activity. Only a percentage of close approaches yield a successful tag attachment, and only a percentage of tag attachments last long enough to obtain sufficient data. We count each approach to an animal separately when we calculate how many approaches are required for a successful attachment, but we will only make three approaches per day to an individual. After that, we will break off and find another individual to attempt to tag. When one approaches a focal animal, other individuals might be near enough to the focal animal to also be near enough to be considered part of the close approach. Similarly when one plays back sound to a focal whale, other animals in the area may also be exposed to the sounds. One goal of the playback experiments is to determine what exposures may lead to enough behavioral disruption to constitute a “take” by harassment. Table 10 and 11 explain the calculation procedure for estimating the takes that are presented in Table 6.

Table 10. Estimation of TAG, CA and FF takes

A. Taxon	B. Tagging Goal	C. Estimated tagging success rate	D. # of tag attachment attempts to meet tagging goal (B/C)	E. Estimated Close Approach Success Rate	F. Estimated group size for CA	H. Estimated # of CA takes Dx F/E	G. Estimated # of FF takes Dx F
Baleen	20 pb proj 2	2/3	30	2/3	3	135	90
	20 ctrl	2/3	30	2/3	3	135	90
Dolphin	20 pb proj 2	20%	100	50%	10	2000	1000
	20 ctrl	20%	100	50%	10	2000	1000
Sperm	20 pb proj 2	40%	50	1/3	3	450	150
	40 pb proj 3	40%	100	1/3	3	900	300
	40 ctrl	40%	100	1/3	3	900	300
Kogia Beaked	20 baseline	20%	100	25%	3	1200	300
	20 baseline	20%	100	25%	3	1200	300

Table 11. Estimation of Playback takes

A. Taxon	B. Playback Goal	C. Estimated group size for playback	D. Estimated playback take BxC
Baleen	20	20	400
Dolphin	20	100	2000
Sperm	40 (average of 2 tagged whales/pb for proj 3)	20	800
Kogia Mesoplodon	0	20	400 incidental in each site for 20 pb
Ziphius	0	20	10x20=200 incidental in Med and Gulf of Mexico

In order to calculate the number of tag attachment attempts required to reach our goal sample of tags for each species, we must estimate success rates for tagging. This tagging success rate is broken down into two components. There is the % of close approaches that yield a tag touch and the % of tags that touch the whale that last long enough to be considered a successful attachment. For baleen whales, attaching the suction cup tags has been quite successful, so we anticipate that at least 2/3 of tags that touch the whale will remain attached for long enough to provide sufficient data. We would therefore request 30 tag attachments for these species in order to meet a goal sample size of 20. We also are able to attach a tag in about 2 out of 3 close approaches, yielding an approach success rate of 2/3. We assume that baleen whales may on average be in groups of about three individuals, so each close approach to a baleen whale for tag attachment may actually involve approach to two whales in addition to the tagging subject. The number of close approach takes would thus be $30 * 3 / (2/3)$ or $270/2 = 135$. We would therefore request 135 close approach takes for 30 tag attachment takes to achieve 20 successful tag attachments with baleen whales. These calculations are illustrated for each

species and each project in Appendix 1 at the end of this application. We apply this same CA group size to estimate the number of focal follow FF takes, but we do not count unsuccessful attempts to attach a tag in estimating the number of focal follows. Some focal follows may start before an animal is tagged, or may involve animals with natural markings. However the majority of follows will take place when the tag is attached for long enough to follow the tagged animal for multiple surfacings. This number is somewhere between the number of tag touches and the goal number of tag attachments. Many of the times when the tag touches the whale and falls off soon thereafter, the vessel approach will only involve a close approach and no follow. On the other hand, some animals may not be tagged long enough for us to consider it a fully successful tag attachment, but long enough for us to have started a focal follow. Therefore, we use as an upper bound of the number of FF takes, the product of the number of tagging takes times the expected number of animals in the group. If we estimate 30 tag attachments to groups of 3 animals, this yields a focal follow count of 90 individuals. This is biased high because many of these tag attachments will not last long enough for a follow.

We have had limited experience attempting to attach Dtags to free-swimming delphinids. Baird has deployed tags of similar size from a pole or cross bow to attach them to bow-riding delphinid cetaceans, but the success rate ranges from 1 success in about 10 attempts to 1 in 3 attempts. If we assume a rate in between these two extremes, a rate of 20% for getting a long enough attachment to obtain the data we require, this suggests a sample of 100 attachment attempts in order to reach a goal sample of 20. These calculations are illustrated for each species and each project in Appendix 1 at the end of this application. While it is relatively difficult with delphinid cetaceans to get a high rate of successful attachments per touch, there is a relatively good success rate of touches/close approach, especially when the animals are bow riding. We assume a 50% approach success rate, indicating a touch is likely in 1 out of 2 close approaches. These animals are often sighted in large groups, but we estimate only up to ten would be close enough to be counted for a close approach. Therefore, to estimate the number of close approaches for species in the “dolphin” category of Table 10, which includes the following species: Pilot whales (*Globicephala* sp.), Killer whales (*Orcinus orca*), False Killer whales (*Pseudorca crassidens*), Risso’s dolphin (*Grampus griseus*), Bottlenose dolphin (*Tursiops truncatus*), Common dolphin (*Delphinus delphis*), Atlantic spotted dolphin (*Stenella frontalis*), Pantropical spotted dolphin (*Stenella attenuata*), Striped dolphin (*Stenella coeruleoalba*), Spinner dolphin (*Stenella longirostris*), Clymene dolphin (*Stenella clymene*), Fraser’s dolphin (*Lagenodelphis hosei*), Melonheaded whale (*Peponocephala electra*), Pygmy killer whale (*Feresa attenuata*), and Rough-toothed dolphin (*Steno bredanensis*), we request $100 \text{ attachment attempts} \times 10 \text{ indiv/group} \times 2 \text{ approaches/touch} = 2000 \text{ close approaches}$. These calculations are illustrated for each species and each project in Appendix 1 at the end of this application. We apply this same CA group size to estimate the number of focal follow FF takes, but following the logic described above for baleen whales, we will use as the upper bound of the number of FF takes, the product of the number of tagging takes times the expected number of animals in the group. If we estimate 100 tag attachments to groups of 10 animals, this yields a focal follow count of 1000 individuals. This is biased high because many of these tag attachments will not last long enough for a follow. I must also point out in addition, that the only reason we list focal follow “takes” is that this is a setting with a non-zero

possibility of disrupting behavior. Following the advice of the NMFS Permit Office we list any settings with a possibility of disruption. In fact, however, our focal follow protocol is designed so that the observation vessels do not affect the behavior of the followed animals.

We have now been tagging sperm whales with Dtags for three years and can use past experience to estimate tagging success. About 4 out of 10 tags that touch the whale attach for long enough for controlled exposure studies, about 4 hours. This yields an attachment success rate of about 40%. At this rate, we would need to request 50 tag attachments for these species in order to meet a goal sample size of 20, 100 attachments for a goal of 40. These calculations are illustrated for each species and each project in Appendix 1 at the end of this application. Our success rate in approaching sperm whales for tagging depends upon how easily approached they are. For some groups, we may approach several individuals the maximum of three times, with no opportunity to tag. In other situations, the success rate is much higher. On average, one out of three approaches allow us to touch the whale with a tag, yielding a rate of 33%. We assume that sperm whales may on average be in groups of about three individuals, so each close approach to a sperm whale for tag attachment may actually involve approach to two whales in addition to the tagging subject. The number of close approach takes to reach a goal of 20 successful tag attachments would thus be $50 * 3 / (1/3)$ or $9 * 50 = 450$. We would therefore request 450 close approach takes for 50 tag attachment takes to achieve 20 successful tag attachments with sperm whales. These calculations are illustrated for each species and each project in Appendix 1 at the end of this application. We apply this same CA group size to estimate the number of focal follow FF takes, but following the logic described above for baleen whales, we will use as the upper bound of the number of FF takes, the product of the number of tagging takes times the expected number of animals in the group. If we estimate 50 tag attachments to groups of 3 animals, this yields a focal follow count of 150 individuals. This is biased high because many of these tag attachments will not last long enough for a follow. In addition, we have lots of experience with focal follow of sperm whales, and little evidence of any behavioral disruption at all from the observation vessels.

It is difficult to assess the success rate for tagging *Kogia* or for the beaked whales of the genera *Ziphius* and *Mesoplodon* with the suction cup tags. We have some experience with attempting to tag beaked whales, with one relatively successful attachment of *Ziphius* lasting through one 14 minute dive. However, unlike sperm whales, we do not have enough experience to calculate rates directly. Baird reports 5 successful tag attachments in 50+ attempts for the northern bottlenose whale, *Hyperoodon ampullatus*. This appears to combine the success rate of approaches and of attachment attempts. Based upon this and our own experience, we will assume a 20% success rate (# successful attachments/touch) for attachment to beaked whales and *Kogia*. We therefore request 100 attachment attempts to these whales in order to reach our target sample size of 20 control tags attached for long enough to obtain the data we require. These calculations are illustrated for each species and each project in Appendix 1 at the end of this application. Beaked whales are not just difficult to tag, but they are also difficult to sight and approach. Based upon our field work, we estimate 4 close approaches are required for one chance to touch an animal with a tag. During our field work with *Ziphius* in the Ligurian Sea, we have followed groups that grew to up to 7

individuals. However, animals are often sighted alone. We assume a group size of three and multiply the number of attachment attempts by 3 to obtain the number of individual beaked whales and *Kogia* that may be closely approached. In other words, on average a close approach to a beaked whale or *Kogia* for tag attachment may actually involve approach to two whales in addition to the tagging subject. The number of close approach takes to reach a goal of 20 successful tag attachments would thus be $100 * 3 / (1/4)$ or $12 * 100 = 1200$. We would therefore request 1200 close approach takes for 100 tag attachment takes to achieve 20 successful tag attachments with beaked whales and *Kogia*. These calculations are illustrated for each species and each project in Appendix 1 at the end of this application. We apply this same CA group size of 3 to estimate the number of focal follow FF takes, but following the logic described above for baleen whales, we will use as the upper bound of the number of FF takes, the product of the number of tagging takes times the expected number of animals in the group. If we estimate 100 tag attachments to groups of 3 animals, this yields a focal follow count of 300 individuals. This is biased high because many of these tag attachments will not last long enough for a follow.

Playback Takes

The goal of the playback experiments will be to assess the received levels at which animals may start to show changes in behavior. The sensitivity and responsiveness of animals is likely to vary within a population. This means that it is essential to conduct playbacks to a sample of animals. On the other hand, there is a limit to the number of animals that can be tagged and followed within several 2-4 week cruises. For most of the species to be studied by tagging individuals for playbacks, we hope for a sample size of 20 focal tagged individuals per year. The sperm whale is the one species for which we propose a more intensive playback focus during two to three cruises annually; for this species we request a sample size of 60 focal whales for playback (20 in the Mediterranean and 40 in the Gulf of Mexico) and 40 control whales.

NMFS (2003) currently suggests an exposure above 160 dB in order to estimate harassment takes. Since the proposed research in the Mediterranean limits exposures to below 160 dB, it would be consistent with current NMFS policy to argue that there is no need to request harassment takes. However, the goal of the research is to enable detection of responses, and it is possible that the NMFS guidelines are not correct and that some behavior may be disrupted in some individuals of some species below 160 dB. Since there is some potential for behavioral disruption, we take a conservative approach in this permit application and request permission for all playbacks, even ones that involve low exposure levels with low probability of behavioral disruption.

Many of our playback subjects are social and are likely to be sighted in groups. We will obtain as much data as possible from other animals within the group, but the primary unit for statistical analysis will remain the playback of a specific stimulus type to focal subjects that have been tagged (McGregor, 1992). As was discussed in the previous section, the number of animals exposed to a playback will be estimated by counting all animals within the group of the focal animal as exposed. We will use a nominal group size of 20 to estimate the number of playback takes for baleen whales, sperm and beaked whales and *Kogia*, and 100 for dolphins. These numbers and the calculations for playback takes are illustrated for each species and each project in Appendix 1 at the end of this application. This is a very conservative estimate, especially for the Mediterranean,

where the range for exposure at 160 dB is just over 300 m. Given that the playback protocols are designed to minimize the chances that non-focal animals will be exposed to higher levels than the focals, even if the focal animal is exposed to a level that evokes behavioral changes, the odds are very low that this many other animals in the area will have exposures that are as high.

For the Mediterranean, we are unlikely to be able to perform a total of more than 20 playback experiments per year. Our sample size of 20 sperm whale playback subjects in the Mediterranean can be met by 20 playbacks there. As mentioned before, while we emphasize sperm whales, it will be very useful to test the whalefinder sonar with other species, where possible. Playbacks in the Mediterranean may be directed at several other species in addition to sperm whales, but there are unlikely to be more than a total of 20 of these Mediterranean playbacks per year. We take a very conservative stance that the maximum number of annual playback takes equals the playback group size times 20 for each species present. This would account either for all 20 playbacks being directed towards any one of the species, or for each species potentially being incidentally exposed to 20 playbacks, or some combination of directed and incidental exposures. The only exception for assumption involves *Ziphius*. We will limit playbacks in the Mediterranean to be away from known habitats of Cuvier's beaked whales. Therefore, we will consider the number of potential unintentional takes of Cuvier's beaked whales from exposure during playbacks to other species to be 10 playbacks X max of 20 animals per group = 200. Given that the exposure beyond 316 m from the source will not exceed 160 dB, we will avoid known *Ziphius* habitat, and that we will stop transmitting anytime a beaked whale is sighted, this is an extremely conservative estimate. In fact, it is extremely unlikely that the behavior of any *Ziphius* will be disrupted by these playbacks.

The playback experiments in project 3 in the Gulf of Mexico will be directed only towards sperm whales. However, it is possible that other species present in the Gulf might incidentally be exposed to the sounds of airguns involved in these playbacks. The sound source used is similar to the commercial seismic survey vessels that ply the Gulf constantly. The potential for incidental harassment takes has not typically been regulated for these commercial vessels, but to be conservative in this research, we acknowledge the possibility that the playbacks might possibly affect the behavior of these other species. NMFS (2003) currently suggests an exposure above 160 dB in order to estimate harassment takes. The propagation of sound from arrays of airguns is complex, but animals within a range of several kilometers could be exposed to these levels. Before any project 3 playback experiments, we will validate propagation models to make sure that we can accurately predict the three dimensional propagation from the source vessel, and we will establish ranges beyond which exposure will not exceed 160 dB. We will carefully monitor visually and with passive acoustics for animals near or within this range, and will count any such sightings as potential incidental harassment takes.

Estimating the number of intentional playback takes to sperm whales and unintentional playback takes for other species in the Gulf of Mexico requires estimating the number of playback experiments. This is complicated by our abilities to tag multiple sperm whales, especially in the Gulf of Mexico for project 3. It has been difficult to attempt to tag multiple sperm whales simultaneously in the Mediterranean, but we have succeeded in doing this in the Gulf of Mexico. Therefore, we assume that we will tag on average 2 whales per playback in the Gulf, so that we can achieve our goal sample size of

40 whale playback subjects by conducting 20 playback experiments in the Gulf. We will calculate the number of playback takes for project 3 with a tagging goal of 40 whales by assuming that on average, we can tag two sperm whales per playback. This would suggest that a goal of 40 subjects would require 20 playbacks.

For unintentional playback takes, whose calculation is shown in Table 12, we use the same group sizes as those estimated above. The only playbacks in the third project consist of playbacks to sperm whales in the Gulf of Mexico. There are unlikely to be more than 20 of these Gulf playbacks per year. All of the baleen whales listed in the take tables, except for Bryde's whale are so rare in the Gulf of Mexico that it is extremely unlikely that we would encounter any. To be conservative, we request two playback takes for each of these species in the Gulf of Mexico. Since a group of 6 humpback whales has been sighted in the vicinity of where some of our playbacks may occur in the Gulf of Mexico, we count this as 2 takes X a group size of 6 for a total of 12 playback takes. We will also request 12 playback takes for the more common Bryde's whale in the Gulf of Mexico. In the Gulf of Mexico, Cuvier's beaked whale tends to be sighted near a water depth of 2000m, while sperm whales tend to be sighted at depths of 1000m. Because the densities of Cuvier's beaked whales are estimated to be low and because of our efforts to conduct playbacks away from Cuvier's beaked whale areas, we consider it very unlikely that *Ziphius* might have playback takes in more than 10 playbacks per year. Therefore, we will consider the number of potential unintentional takes of Cuvier's beaked whales from exposure during playbacks to sperm whales to be 10 playbacks X max of 20 animals per group = 200. For other species that occur in the the Gulf of Mexico, we will make the conservative assumption that there could be one group taken during each playback, so will multiply the number of playbacks by the estimated group size for each species. This makes the multiplier 20 X group size for species that only occur in one or the other of the two playback sites, Gulf of Mexico and Mediterranean, and 40 X group size for species that only occur in both sites.

Table 12. Method of calculating directed and unintentional or incidental takes during playback.

A. Location of taxon	B. Annual Number of Playbacks	C. Estimated group size for playback	D. Estimated playback take BxC
Mediterranean	20	Dolphins 100	2000
Mediterranean	20	Sperm Whale 20	400
Mediterranean	20	Other 20	400
Mediterranean	0	<i>Kogia, Mesoplodon</i> 20x20	400 incidental
Mediterranean	0	<i>Ziphius</i> 10 x 20	200 incidental
Gulf of Mexico	0	Dolphins 100	2000 incidental
Gulf of Mexico	20	Sperm Whale 20	400
Gulf of Mexico	0	Humpback and Bryde's whale 2 x 6	12 incidental
Gulf of Mexico	0	Blue fin sei and minke whale 2	2 incidental
Gulf of Mexico	0	Other 20	400 incidental

Gulf of Mexico	0	<i>Ziphius</i> 10 x 20	200 incidental
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3. Research in the Wild

Description of techniques and equipment used to approach and tag animals

a) The kinds, numbers, and sizes of samples to be taken and the sampling method

As described above, the only tissue samples to be taken from marine mammals involve the collection of skin that may adhere to the tags. When tags are recovered, we will carefully inspect for any sloughed skin that may have adhered to the greasy coating of the suction cup used for attaching the tag. Any such skin will be collected for genetic analyses (Amos et al., 1992). Thus the maximum number of samples would equal the number of tagging takes for each species as indicated in Table 10.

For project 1, we propose to tag a variety of species in the North Atlantic and Mediterranean. As per Table 6, Waring (2001) and Gannier (1998), species to be tagged include *Megaptera novaeangliae*, *Balaenoptera acutorostrata*, *Balaenoptera edeni*, *Balaenoptera borealis*, *Balaenoptera physalus*, *Balaenoptera musculus*, *Physeter macrocephalus*, *Mesoplodon* sp., *Ziphius cavirostris*, *Hyperoodon ampullatus*, *Globicephala* sp., *Grampus griseus*, *T. truncatus*, *Delphinus* sp., *Stenella coeruleoalba*, *Stenella frontalis*, *Stenella attenuata*, *Steno bredanensis*, *Stenella longirostris*, *Stenella clymene*, *Lagenodelphis hosei*, *Kogia* sp., *Orcinus orca*, *Peponocephala electra*, *Feresa attenuata* and *Pseudorca crassidens*. Project 2 involves tagging most cetacean species present in the Mediterranean for testing of a whalefinding sonar, including *Balaenoptera physalus*, *Balaenoptera acutorostrata*, *Physeter macrocephalus*, *Globicephala* sp., *Grampus griseus*, *T. truncatus*, *Delphinus* sp., *Stenella coeruleoalba*, *Steno bredanensis*, *Orcinus orca*, and *Pseudorca crassidens*, but with the exception of beaked whales of the genera *Mesoplodon* and *Ziphius* and *Kogia* spp. These latter species would only be tagged in the Med for baseline behavioral observations under project 1. Project 3 involves tagging sperm whales in the Gulf of Mexico to study their responses to the sounds of airguns. No other species will be tagged for this project 3.

b) Electronic tags

(1) Description of DTAG

The DTAG is the name we have given to a miniature solid-state acoustic recording tag. We have built two versions of the DTAG. The first version DTAG1 has worked very well for large whales such as sperm and baleen whales. The second version DTAG2 is smaller, with capabilities for higher acoustic sampling rates. We hope that these will improve its performance for smaller whales, and those that may produce higher frequency sounds. However, they both are excellent for specific applications, and we propose to use both of them for the research to be conducted under this permit application. The DTAG uses solid-state non-volatile memory in place of magnetic media to overcome the limitations of hard drives which necessitate pressure housings. This has the advantage that the tag can be potted, eliminating the need for a pressure housing and enhancing the robustness of the device. The dimensions of the first version of the tag DTAG1 are approximately 4" by 3" by 1", a dramatic improvement over existing tags.

The precise metric weight and dimensions of the first version of the tag including baleen whale attachment are as follows:

DTAG boards only	58g
Potted DTAG with hydrophone	210g
Battery pack (Ultralife)	25g
Full-up system (Y2K baleen whale model, includes fairing, flotation, cup set, VHF beacon, DTAG and batteries)	447g

Dimensions, Y2K baleen whale model

length (excluding VHF antenna)	300mm
width (across forward cups)	200mm
height (when deployed)	84mm

During the spring of '03, Mark Johnson of the WHOI Department of Applied Ocean Physics and Engineering designed a second version of the Dtag DTAG2 that is smaller with more advanced capabilities and fabrication is well advanced. We are building an initial quantity of 25 tags. All parts except for the FLASH memory have been procured. FLASH memory for 6 tags (3GB/tag) has been purchased and we will buy the balance when needed to ensure the best price. The DTAG2 outside dimensions (including packaging) are 4.4"x1.6"x1", which is 40% of the volume of DTAG1. The new tag has a modular audio acquisition section and can be assembled with a high performance stereo ADC (24 bits, 96kHz/channel) suitable for sperm whales and baleen whales, or with a high speed ADC (12 bits, 300-400kHz, single channel) for small odontocetes. The sensor suite of DTAG1 has been kept on the new tag and an EKG sensor has been added.

We have designed a fairing for odontocetes that will be smaller than the model used successfully with baleen and sperm whales. Initially the memory capacity was 400 MBytes but new chips have become available that allow a memory capacity of up to 2-3 Gigabytes. The DTAG incorporates a digital signal processor capable of real-time detection and compression of audio signals, making efficient use of the memory. The sampling rate and compression algorithm used by the tag are fully programmable. The tag also includes sensors for pressure, pitch, roll, heading, surfacing events, and temperature. All programming and data offload occur through an infrared communications port enabling the entire system to be potted, further increasing the efficiency and robustness of the instrument in the field. The DTAG itself has no inherent attachment mechanism. This was a purposeful design so that attachment can be customized for the species being studied.

(2) Method of attachment

The DTAG was designed to acquire data at high rates so that fine details of an individual's behavior can be documented. Being a high data rate tag, the DTAG need only be attached to an animal for relatively short periods of time (i.e. 5-48 hours). We believe that non-invasive attachment mechanisms are the most appropriate to meet our

target life of hours to a day or two. The most appropriate non-invasive attachment method for using our tags with most cetacean species involves the use of suction cups. The DTAG itself does not include an attachment mechanism, an intentional strategy to allow for specialized attachment techniques for the species being studied.

(3) Method of application

The basic principle for tag delivery is to conduct it in such a manner as to minimize the potential for disturbing the whale. For large, slow moving whales, we use a pole delivery system similar to that developed by Moore *et al.* (2001) for right whale blubber thickness measurement. This uses a 10-12 m pole cantilevered from the bow of a small boat to attach the tag from greater distance than is typically possible with pole deployments. In some settings, for example with beaked whales or bow-riding dolphins, it may be simpler to hand hold a 2-4 m pole to deploy the tag. Baird successfully attached tags similar to the DTAG to porpoises in Puget Sound (Hanson and Baird, 1998) and pilot whales in the Mediterranean using this approach. Our successful attachment of a Dtag to a *Ziphius* was achieved using this kind of hand-held pole. In some settings, such as with larger fast-moving odontocetes that do not bow-ride, it is preferable to use a cross bow to apply the suction cup tag remotely. Baird (1994) for example, has found the cross bow to be the best attachment method for killer whales. In this case, the slight loss of precision in location of attachment is outweighed by the ability to rapidly attach the suction cup tag remotely from a greater distance. Following the success of cross bow attachments, we also propose to consider the cross bow as a potential fall back attachment method for our suction cup tag.

The tagging protocol for each species will differ according to its morphology and environmental conditions but will follow a general model. Where possible an observation and tracking vessel (OV) will use visual observation and acoustic monitoring to follow a whale selected for tagging. The observers will monitor this whale as carefully as possible before tagging so that these observations can be used to test for any effects of tagging itself. The tag attachment vessel (TAV) will approach the animal as cautiously as possible while still achieving a position to allow attachment of the tag. During and after attachment, the observation and tracking vessel (OV) will track and observe the animal when it is at the surface for the duration of the tag attachment as well as a post-tagging period, where possible, to ensure both that the data collected during the tag's life represent as normal a repertoire as possible and that the tag had no visible effects on the animal. Sightings from the OV are also used to locate the whale's track in geographical space. Either the tagging vessel or the OV will recover the tag after it releases from the animal. Where playbacks are planned, they will be conducted only after a specified pre-exposure period to monitor the animal's reaction to the tagging and to establish a pre-exposure behavioral baseline. We will take photos of all animals tagged, and where possible, tagging attempts, and tag location on the animal. We will use these photos to identify the tagged animal, i.e. to compare to known catalogues for information about tagged individuals and to prevent duplicative tagging.

(4) Location of attachment

The tags are attached on the dorsal surface of the animal caudal to the blowhole and closer to the dorsal fin than to the blowhole. Some delphinid attachments may be placed on the dorsal fin.

(5) Duration of attachment

Since our tags attach with a suction cup, if a whale is bothered by the tag, the whale can remove it by maneuvering rapidly, by breaching, or by rubbing the tag off on a solid surface. We have repeatedly been able to obtain attachment durations of 4-12 hours on sperm whales, up to the maximum programmed recording time, in the past few years of work under permit no. 981-1578. The playback design requires tags to be attached for about four to twelve hours, and our target attachment duration is 4-12 hours.

(6) Method of release:

The tag can release from the animal in at least three ways. First, if an animal is bothered by the tag, the animal can dislodge it by rapid movements, by rubbing it on the seafloor, or by contact with another animal. Second, the tag can simply release on its own due to slow leakage of the seal between the cup and the animal's skin, repeated diving (i.e. pressure changes) working the suction cups loose, some other mechanical failure, or releasing with sloughed skin. Finally, we have a release mechanism that uses an electrically corrosive wire assembly to release the tag package (DTAG, batteries, flotation, suction cups, plastic housing, and RF transmitter) from the whale. The corrosive wire assembly opens a tube to release the suction, and is not in contact with the whale at any time so poses no threat. Because the tag is attached caudal to the blowhole it has no chance of interfering with breathing as the tag migrates caudally as the animal moves.

c) **No drugs to be used.**

d) **No restraint**

e) **Methods of tissue sampling and types of samples**

See (a) above

f) **No pinniped pups will be taken.**

g) Types and operational characteristics of the research vessels

This field work will require vessels to perform several different functions: tag attachment, whale/tag tracking, whale and vessel observation, playback, and acoustic monitoring. In some cases, the same vessel can play several of these roles. We will discuss each function separately:

Tag attachment vessel (TAV): Tag delivery will be conducted to minimize the potential for disturbing the whale. We propose to use small maneuverable vessels for tag attachment. We have successfully used 5-15 m vessels for attaching tags to whales in 1998 - 2002, with minimal signs of disturbance using a 12+ m long cantilevered pole. We propose to attach tags using a cantilevered pole deployed from the same kind of vessel or from a slightly larger vessel with species for which it is appropriate. We also propose to attempt to tag slow moving animals by approaching them slowly by paddling

or rowing in small 3-5 m vessels. In some settings, such as with bow-riding dolphins, it may be preferable to use a vessel that is fast enough for dolphins to bow-ride. Baird has been successful attaching tags to bow-riding small odontocetes using pole deployment. If necessary, we may use a crossbow for remote attachment with larger fast-moving odontocetes that do not bow-ride.

Whale Observation/Tag tracking Vessel (OV or WTV): The primary requirement for the whale tracking vessel (WTV) are:

- height for antenna placement and for visual observations
- silent propulsion and ability to deploy hydrophone array
- ability to deploy tagging vessel
- cabin and bunk space for tagging team, visual monitors, and a crew of acoustic monitors to operate around the clock

A large quiet research vessel is optimal for this task. One critical component of the playbacks involves accurate assessment of range from the playback speaker to the focal whale. We will measure the angle between a surfacing animal and the horizon or use laser rangefinding binoculars to calculate range for animals visually sighted at the sea surface. In some circumstances, it is possible for the acoustic monitors to estimate the range to vocalizing animals as well (Thode et al. 2002). If the OV and PBV are separate vessels, we will have a data link between them to allow each platform to plot the locations of ships and whales in close to real-time.

Playback vessel (PBV): The playback vessel will be used to deploy the sound source and playback the experimental stimuli. It must have hardware for deploying and towing sources and suitable deck or lab space for the airgun source equipment or sound generation electronics (computer, power amplifiers, etc.). One critical component of the playbacks involves accurate assessment of range from the airgun array or playback speaker to the focal whale. We will use laser rangefinding binoculars or measure the angle between a surfacing animal and the horizon or to calculate range for animals visually sighted at the sea surface. In some circumstances, it is possible for the acoustic monitors to estimate the range to vocalizing animals as well (Thode et al. 2002). This vessel must have a relatively quiet propulsion system to minimize potentially confounding vessel noise.

(1) Descriptions of each project covered by this permit

(a) Project 1: Tagging whales to determine baseline behavior

We propose to tag whales without conducting playback experiments in a variety of settings. A major source of uncertainty for population estimates derived from visual sightings of whales concerns uncertainty over the correction factor that should be applied to sighting data. We propose to collaborate with NMFS Northeast Fisheries Science Center on cruises in the North Atlantic to tag baleen whales and toothed whales to obtain detailed dive data for measuring the correction factor. The ability of the tag to detect the

sounds of blows as well as surface time adds to the data required to estimate probability of detecting a whale.

We are also using the Dtag in several settings to record the location and depth of vocalizations from tagged individuals to test the probability with which passive acoustic monitoring systems detect the calls. This kind of data has been collected and analyzed in collaboration with scientists at the International Fund for Animal Welfare to evaluate the potential for passive monitoring to locate whales (Mathews et al. 2001).

The Dtag provides detailed data on behavior and acoustic exposure of whales in baseline conditions, which will also help provide baseline and control data for our understanding of effects of noise on these species. For example, few of our data sets from sperm whales tagged in the Gulf of Mexico are free from the sounds of airguns of commercial seismic surveys. This means that we have little truly baseline data to define undisturbed behavior. Baseline observations of sperm whales tagged in areas without seismic surveys will be important control observations for our CEEs with sperm whales in the Gulf.

In addition, we propose to tag mid-sized toothed whales such as beaked whales, species for which there is a correlation of strandings in association with naval maneuvers (e.g., Simmonds and Lopez-Jurado, 1991; Frantzis, 1998), especially those using mid-frequency sonars (Evans and England 2001), and pilot whales, which have been reported to respond behaviorally to sonar sounds (Rendell and Gordon, 1999), and which regularly strand *en masse*, but for which there is no correlation between strandings naval maneuvers. The Saclant Underwater Research Centre (Saclantcen) has collated sighting and stranding records for beaked whales in the Mediterranean, and has dedicated portions of research cruises to surveying for these and other species (Figure 1). In addition, there is a thriving whale watching industry in the northern Ligurian Sea, for which Cuvier's beaked whale, *Ziphius cavirostris*, is the fourth most commonly sighted species. We are working both with whale watchers and Saclantcen to understand the distribution of beaked whales and to tag them to study their vocal and diving behavior. We hope that the tag data and other recordings will help us to identify the vocalizations of *Ziphius*, currently poorly described in the literature, which may enable acoustic detection and monitoring. It also may help us to understand their foraging and social behavior, which may help us to predict where they are found, and potential impacts of sound on social behavior. We also hope to develop several other field sites for studies of baseline behavior of beaked whales in the Mediterranean or North Atlantic. For example, beaked whales are often sighted in the Canary Islands in settings appropriate for tagging, and we plan pilot field efforts to find additional promising sites for long term studies.

Our pilot data from pilot whales uses data from well-known vocalizations of this species in order to study social coordination and communication. This has been very successful and for several species with regular vocalizations we plan to tag multiple individuals within groups in order to study social coordination and communication. Once these patterns are well understood, they may ultimately enable playback experiments to study the impact of manmade noise disrupting these subtle social functions of communication.

(b) Project 2: Tests of a whalefinding sonar in the Ligurian Sea

Some sound sources are so loud that they create a risk of injuring animals that are too close. This zone of potential injury may measure hundreds or even thousands of meters away from some sources (Richardson et al., 1995). This creates a need to monitor to ensure that marine mammals or other endangered marine animals such as sea turtles are not in this potential zone of injury. It has been increasingly recognized that current visual and passive acoustic monitoring techniques are not 100% effective for this monitoring task. This recognition has led to considerable recent effort to develop active sonars that can detect marine mammals or sea turtles within a range of 1-2 km. We propose to use DTAGs to help calibrate measurements of the Target Strength of marine mammals as a function of aspect, and to validate the effectiveness of these sonars in detecting marine mammals. DTAGs will also provide a sensitive tool to monitor potential reactions of marine mammals to the sounds of whalefinding sonars designed to maximize detection of animals while minimizing impact.

We propose to tag animals before tests of a whalefinding sonar for marine mammal detection during research cruises in the Mediterranean Sea. This is the same design for a whalefinding sonar as described in the initial application for permit 981-1578. This whalefinding sonar was developed by the Saclant undersea research center in Italy. It is designed to be used from a ship that is underway and uses a sound source that broadcasts in all directions and a directional receiver that can simultaneously locate echoes from all directions. We propose to test variety of different cetaceans for this project, but the species that we have primarily emphasized for this work is the sperm whale because we can reliably tag it for long periods, it vocalizes most of the time, so we can track it in real time, and as a large whale, it should provide a strong echo.

It is useful to use the natural click sounds of sperm whales as a control stimulus for evaluating behavioral responses by the whales to the whalefinding sonar. This kind of natural control stimulus allows us to compare any responses we might note during sonar transmissions to the normal behavioral repertoire of responses to natural sounds. For the control sounds, we propose to play back sperm whale coda signals, which are series of clicks with a total duration not longer than a few seconds (Watkins and Schevill, 1977). Each individual click has a short (20-40 msec) duration (Madsen et al. 2002). The source level of these clicks is about 160-180 re 1 μ Pa at 1 m (Richardson et al. 1995, Table 7.2; Madsen et al. 2002), and we will limit the source level for coda playbacks to a maximum of 180 re 1 μ Pa at 1 m. We propose to initially use a playback of a series of codas with a duration that may last up to several minutes. None of the individual clicks in our coda playback signals last for longer than several tens of msec, and none of the overall coda series will exceed a duty cycle of more than 1% whatever the duration of transmission.

The low-power sonar described in the original application for permit no. 981-1578 used source levels of 160-180 dB re 1 μ Pa at 1 m, and the first amendment for permit no. 981-1578 included source levels of 160-200 dB re 1 μ Pa at 1 m for the same sonar. The sonar source uses 4 elements mounted in a fish that can be towed from a research vessel designed for acoustic research. Unfortunately, no echoes from sperm whales have been detected using these source levels, which indicates a need to increase the source level by one more increment. We propose in this permit application to use a maximum source level of this whalefinder sonar of 210 dB rms re 1 μ Pa at 1 m. Even at the maximum source level of 210 dB, an animal as close as 30 m away would not be

exposed to sound levels above 180 dB, and an animal as close as 317 m away would not be exposed to sound levels above 160 dB. The closest we can typically approach a diving sperm whale is about 1000 m, so this source level would make it unlikely that we would expose our focal animal to levels above 150 dB.

The signals to be used for active ranging on marine mammals include some subset of the following:

Source levels: 160dB-210 dB rms re 1 μ Pa at 1 m, not to exceed 160dB at the animal.

Signals:

Chirp upsweeps centered at 1kHz-12kHz.

Bandwidths: 100-400Hz.

Pulse Durations: 50-400ms.

Pulse repetition: No more than 1 ping per 15 sec.

When the whale finding sonar starts transmitting, it will use a ramp up procedure designed so that any marine mammal has time to swim out of the zone ensonified at levels of 160 dB or more (following the calculation of required swimming speed shown below in Table 13). Any target in an exposure zone near 160 dB will be tracked for potential responses. Because of spreading loss and attenuation at these frequencies, the sound level should not exceed 160 dB re 1 μ Pa rms beyond 317m. Animals can be tracked visually from the ships well beyond this range.

The goal of this project is to field test the whalefinding sonar with marine mammals that are common in the Mediterranean Sea. The main focus of the research will be sperm whales, but there is a need for testing how well the sonar works for detecting the variety of species present in this area, so for these tests, we propose to tag any of a broad variety of species that may be encountered in this area, including finback whales, sperm whales, pilot whales, Risso's dolphin, bottlenose dolphins, common dolphins, and striped dolphins (Gannier, 1998). Given the potential that beaked whales and possibly *Kogia* may be particularly sensitive to mid-frequency sounds, we will not conduct any tests of the whalefinding sonars to *Kogia* or beaked whales, nor will we transmit anywhere near the *Ziphius* habitat identified in the Ligurian Sea (see Figure 1).

During the past four years, Italian researchers have collaborated with Saclantcen to map all known sightings and strandings of beaked whales in Italian waters. The sighting effort has included many seasons of sightings from whale watching vessels that regularly sight beaked whales and also several cruises devoted to studying beaked whales especially. Cuvier's beaked whale has a very predictable sighting pattern, being sighted in deep waters of the northern Ligurian sea near the Genoa canyon (Figure 1), especially areas with a steep gradient of bathymetry. On the other hand, even though the same observers have had many days of superb sighting conditions outside of this area, no beaked whales have been sighted with the same observers who sighted the *Ziphius* in the Genoa canyon area (Figure 1). We propose only to conduct tests of the whalefinding sonar outside of this area where *Ziphius* is predictably sighted, to minimize the chance that they might by accident be near the sonar while it is transmitting.

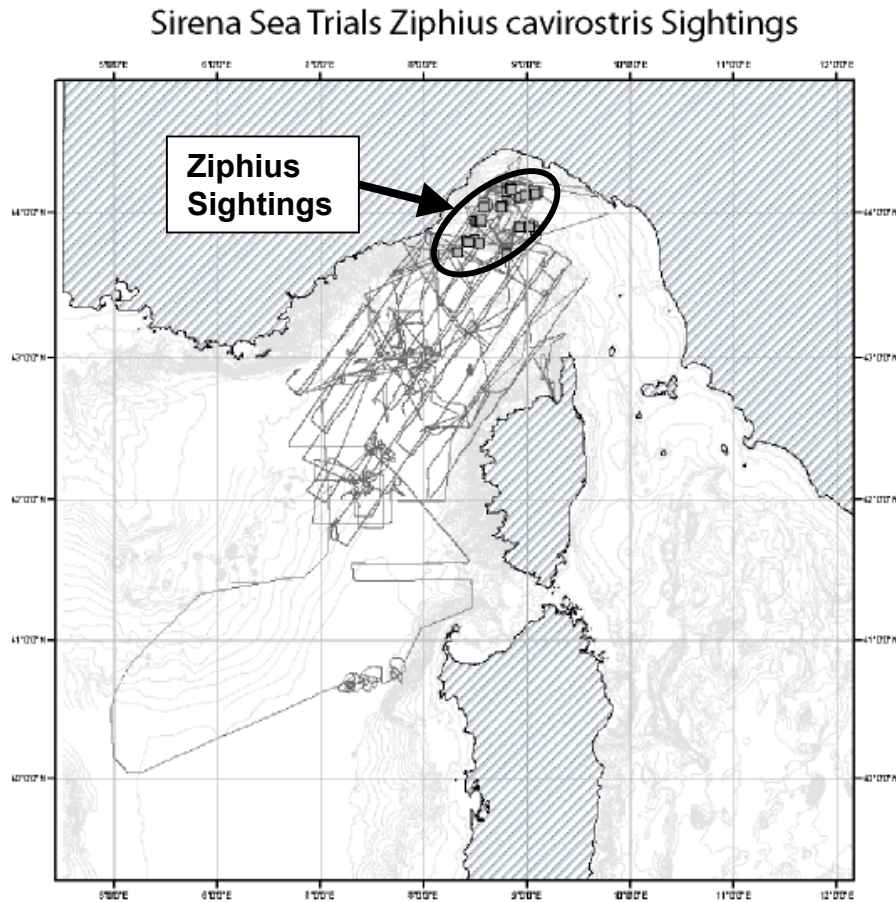


Figure 1. Survey tracks for marine mammals during Sirena cruises 1999-2002 (solid line) along with sightings of Cuvier's beaked whale, *Ziphius cavirostris* (square symbols). Courtesy Saclantcen.

The goal of the tagging component of project 2 is to use DTAGs to measure the received level of transmissions at the animal, to measure the orientation and depth of the animal in order to assess variation in Target Strength (TS) with aspect and depth, and to measure any potential reactions of the tagged animals to sonar sounds. The DTAG has a three-axis magnetometer that can sense the orientation of the whale with respect to the earth's magnetic field. By comparing the whale's heading against the bearing from the ship to the whale with respect to ship's heading, it is possible to estimate the aspect of the whale to the sonar. Using data from the first cruises under permit no. 981-1578, Zimmer et al. (2003) have validated our ability to link data from the tag on the whale and beamformer on the source ship to pinpoint the location and orientation of the whale. The hydrophone on the DTAG can also precisely measure received level (RL) of a sonar transmission at the tagged whale. If the Source Level (SL) of the transmission is known, then these data enable a precise calculation of Target Strength (TS) of the whale as a function of aspect. Since $TL = SL - RL$, measurement of SL and RL allows calculation of TL. The basic sonar equation is $RL(\text{back at sonar}) = SL - 2 TL$ (round trip transmission loss) + TS. Therefore, if we know the SL and measure the RL on the tag, we can

calculate Target Strength (TS) from the measurements on a ping-by-ping basis as a function of aspect.

The research cruises for project 2 will typically last about 10-20 days. At the start of the cruise, we will usually conduct an engineering test to calibrate the sound sources. This is important to validate the models used to predict the received level of sound at the whale as a function of range and depth. For this preliminary test, we will select an area with low density of marine mammals and an environment far from the beaked whale habitat shown in Figure 1. We will only start transmitting after monitoring visually and acoustically for 30 min with no detections of marine mammals. The source level will be ramped up starting at 162 dB re 1 μ Pa rms at 1 m by no more than 6 dB every two minutes. As Table 13 shows, this two minute increment allows any whale or sea turtle as close as 1 m from the source, plenty of time to swim away at 2 m/sec (an easy swim velocity for many species) to get beyond the 160 dB exposure range. If any marine mammals are detected within the 160 dB zone, corresponding to 317 m for the maximum source level of 210 dB (assuming spherical spreading), the source will be shutoff until none are detected for 30 minutes again. The basic plan for this test is to use a buoy or boat to deploy a calibrated sonar target (not an active source, but just an object where it is known how much incident sound energy is reflected back) and an array of calibrated hydrophones deployed vertically in the water, then for the source vessel to run a pattern around the hydrophones. This allows us to validate precisely how sound is propagating from the source to be used in the playbacks.

Table 13. Distance whale must swim during rampup to remain farther than 160 dB zone.

Source Level re 1 μ Pa rms at 1 m	Range to 160 dB (20 log Range)	Dif in range to previous 160 dB range	Swim velocity to swim this distance in 2 min (m/sec)
162	1		
168	3	1	0.01
174	5	2	0.02
180	10	5	0.04
186	20	10	0.08
192	40	20	0.17
198	79	40	0.33
204	158	79	0.66
210	316	158	1.31

After the engineering test and validation, we will switch to the protocol for playbacks. Early each morning, the ship will use its passive hydrophone array and beamforming system to locate calls of marine mammals, with a primary focus on sperm whales. If calls are detected, the ship will move near the animals. Visual observers on both the playback vessel and the tracking vessel (if a separate tracking vessel is used) will start a lookout for animals as soon as sufficient daylight is available. If there are marine mammals in the vicinity, the ship will launch the tag attachment vessel once it is light enough to do so. The tagging vessel will primarily direct its efforts to sperm whales, but may attempt to tag whatever species are present. If beaked whales or *Kogia* are sighted or tagged, no sounds will be transmitted. Otherwise, once an animal or several animals have been tagged and pre-exposure behavior collected, the ship will maneuver within 2 km or

so of the tagged animals and prepare to start transmitting sonar signals both to test the system's ability to detect whales and to evaluate possible reactions.

Sounds will only be transmitted following a careful ramp up and monitoring procedure. Visual and acoustic monitors will work for half an hour to see if any animals might be within the 160 dB re 1 μ Pa rms maximum exposure zone. If none are detected near this zone during the entire time, sounds will be started at a source level of 162 dB re 1 μ Pa rms at 1 m, and the source level will be increased by 6 dB every 2 minutes until it reaches the planned level up to a maximum of 210 dB re 1 μ Pa rms at 1 m. As Table 13 shows, this two minute increment allows any whale or sea turtle as close as 1 m from the source, plenty of time to swim away at 2 m/sec (an easy swim velocity for many species) to get beyond the 160 dB exposure range. Visual and acoustic monitoring will continue during the entire transmission period, and these monitors will have the source shutdown if any animal comes near the maximum exposure zone. These transmissions to a tagged animal will last for between one to three hours, and transmissions will cease if there is any indication of an adverse behavioral reaction. After this exposure period, we will follow the tagged animal(s) to collect post exposure data until the tag(s) release. If time allows, we will repeat the process of searching for a new subject, attempting to tag etc. more than one time per day.

(c) Project 3: Responses of sperm whales in the Gulf of Mexico to playback of coda vocalizations and sounds of airgun arrays used in seismic surveying.

Technical advances in the oil industry allow exploration and drilling for petroleum in much deeper water than in the past. As oil industry activities move into the deep water habitat of sperm whales, this means that these activities may have an increasing potential for impact on deep divers such as sperm whales. There are conflicting accounts on whether large deep diving toothed whales such as sperm whales may be particularly sensitive to short impulsive manmade sounds. Watkins and Schevill (1975) report that sperm whales silence when exposed to pingers at sound source levels as low as 110-130 dB re 1 μ Pa at 1 m. Mate et al. (1994) suggest that sperm whales in the Gulf of Mexico may have moved as far as 50+ km away when seismic surveying began in the area. However, an analysis of survey data from the Gulf of Mexico failed to find any effect of seismic survey on sightings of odontocetes (Rankin and Evans 1998, Rankin, 1999). Bowles et al. (1994) showed that sperm whales in the southern Indian Ocean tended to stop vocalizing when an airgun array was operated 300 km away. In contrast, Madsen et al. (2002) report that sperm whales did not stop vocalizing when exposed to seismic sounds up to 146 dB re 1 μ Pa pk-pk. Our own results from CEEs to four sperm whale last summer suggest minor responses if any, to exposures in the 143-148 dB re 1 μ Pa rms, at ranges of 7-16 km. Observers on or near seismic vessels also found little evidence of avoidance or disruption for sperm whales in the presence of seismic survey near UK waters (Stone, 1997, 1998, 2000, 2001), but these results may be biased if more sensitive animals moved away before they could be detected. A study of acoustic detections of sperm whales at different ranges from seismic survey was less subject to this bias, and also found no obvious changes in the behavior or distribution of sperm whales (McCall Howard, 1999).

The conflicting results cited above make it impossible to predict what levels of exposure are safe, and what may lead to significant disruption of critical behaviors. A

major obstacle to these studies concerns our inability to monitor responses when whales are at depth. Acoustic recording tags have recently been developed that can solve this problem of measuring the stimulus an animal hears from a noise exposure as well as a variety of potential response measures (Burgess et al., 1998). Mark Johnson and Peter Tyack of WHOI have developed a small sophisticated digital acoustic recording tag, the DTAG, that will play a critical part in the research proposed in this permit application as a method to study this problem (Johnson and Tyack 2003).

We propose studies to monitor responses of sperm whales to experimental playbacks of humanmade sound in the Gulf of Mexico. According to Cranswick and Regg (1997), 83% of the crude oil production and 99% of the gas production in US Federal waters occurs in the Gulf of Mexico. Most projections predict strong expansion of oil industry activities in the deep water habitat of sperm whales in the Gulf of Mexico. Rankin and Evans (1998) and Rankin (1999) found no difference in sighting frequency of odontocetes other than sperm whales as a function of exposure to seismic noise. However, this kind of large scale study is not sensitive to potential behavioral reactions, and Davis et al. (2000) recommend controlled experiments on the effects of seismic sounds specifically on sperm whales.

We propose a series of controlled exposure studies, or playback experiments, to resolve differences in results from earlier studies of how likely sperm whales are to silence, move away, or show other disruption of behavior when they are exposed to impulse sounds from an airgun array vs natural control sounds. These studies will involve visual observations of surfacing sperm whales, passive acoustic tracking of diving sperm whales, and tagging sperm whales with DTAGs.

Most data on responses of sperm whales to manmade sounds concern sounds from airguns used for seismic exploration, and this is the sound source of most concern for sperm whales in the Gulf of Mexico. Airguns generate sound by releasing compressed air into the seawater from a chamber. As the bubble expands and collapses, it generates an impulse sound. The seismic industry is primarily interested in directing sound energy down into geological strata below the seafloor; it uses arrays of airguns to sharpen the wavefront of sound energy directed downwards.

The sound levels of airgun pulses are reported using different measures, each of which give levels that vary considerably for the same waveform. It is critical to take into account the measure being used when interpreting quoted source or received levels. Geophysicists usually report peak-to-peak levels (p-p), in bar-meters or dB re 1 $\mu\text{Pa}\cdot\text{m}$, or zero-to-peak levels (0-p). The zero-to-peak level for the same pulse is typically about 6 dB less than the peak-to-peak (Greene, 1997). When considering behavioral effects, biologists and NMFS usually describe levels of received airgun pulses in terms of the “average” or “root-mean-square” (rms) level over the duration of the pulse, which is typically about 10 dB lower than the zero-to-peak level, and 16 dB lower than the peak-to-peak value of the same pulse (Greene, 1997; McCauley et al., 1998, 2000a). However, it is important to note that this depends upon the waveform of the signal, and is an empirical observation, not a true conversion factor.

The duration of airgun impulses depends upon the range from the source. Seismic pulses recorded at the source have durations typically ranging from 10 to 20 ms. At a distance from the source, the seismic pulse may arrive from several different paths, each of which has a different duration. This has the effect of lengthening the duration of the

received pulse. Greene and Richardson (1988) report that an airgun array operating in the Beaufort Sea yielded pulse durations of about 300 ms at a distance of 8 km, 500 ms at 20 km, and 850 ms at 73 km. Often these arrivals are separated enough in time to allow measurement of the level of each arrival, but the signal changes duration sufficiently that the biological effect on an animal may vary with this spreading out of duration with range.

An individual airgun generates a sound with a level of 215-230 dB re 1 μ Pa p-p at 1 m, depending upon the size of the airgun (Richardson et al. 1995; Table 6.6). Full airgun arrays direct sound energy downwards efficiently enough to have effective source levels of up to 250-260 dB re 1 μ Pa p-p at 1 m within the downward directed beam. The individual airguns are far enough apart that there is reported to be no region where the sound level exceeds 230 dB re 1 μ Pa p-p, but the signals from all of the airguns in the array reinforce at far ranges in the direction below the array to yield this apparent level. It is not a true source level, but rather represents the equivalent level it would take for one source to produce the same signal measured far enough away that the multiple sources can be treated as one. On the other hand, at horizontal angles from the array, the signals from the different airguns in the array interact in complex ways often with little reinforcement. For example, in our research last summer, we recorded sound levels of 143 dB re 1 μ Pa rms at a range of 16 km and of 148 dB re 1 μ Pa rms at a range of 7 km from a 1680 cu. in. airgun array. This suggests that the level at 10 km would be about 145 dB re 1 μ Pa rms. Given spherical spreading ($20 \log r$), the transmission loss from 1 m to 10000 m would be $20 \log 10^4$ or 80 dB. The water depth was about 1 km. If we assume spherical spreading from 1-1000 m and then $15 \log$ range from 1000 to 10,000 m, this would yield a transmission loss of 75 dB. This would correspond to an effective source level of $145+75-80 = 220-225$ dB re 1 μ Pa rms, similar to that from a single airgun for which the corresponding 0-p level would be about 230-235 dB re 1 μ Pa 0-p.

We propose to use two different kinds of sounds as playback stimuli. Impulse sounds from airguns typically have peak energy below 100 Hz (Richardson et al., 1995), but the initial stages of the impulse have considerable energy at higher frequencies, even above 1 kHz (Goold and Fish, 1998). Our measurements of pulses from an airgun array recorded last summer at shallow depths found significant energy at energies as high as 2-3 kHz. These impulse sounds share similarities with the clicks made by sperm whales, so it is useful to use the natural click sounds of these animals as a control stimulus. For the control sounds, we propose to play back sperm whale coda signals, which are series of clicks with a total duration not longer than a few seconds (Watkins and Schevill, 1977). Each individual click has a short (20-40 msec) duration (Madsen et al. 2002). The source level of these clicks is about 160-180 dB re 1 μ Pa at 1 m (Richardson et al. 1995, Table 7.2; Madsen et al. 2002), and we will limit the playback source level to 180 dB re 1 μ Pa at 1 m. We propose to initially playback a series of codas that may last up to several minutes. This is a common pattern when sperm whales produce codas, and is not that different from series of pulses from airguns, which typically broadcast one impulse every 10-15 seconds, although the airguns typically operate in much longer series. None of our individual clicks used as playback signals last for longer than several tens of msec, and none will exceed a duty cycle of more than 1% whatever the duration of transmission.

For airgun signals, it would be possible either to use an individual airgun or airgun array to study responses of sperm whales to these impulse sounds. An individual

airgun has an omnidirectional beam pattern, making it easier to predict exposure to a whale displaced laterally from the array. However, the signals of individual airguns may differ somewhat from those of the arrays of airgun arrays used by the seismic industry. Airgun arrays have complex patterns of sound propagation, especially when recorded at a horizontal offset. The level and spectra of the pulses vary as a function of recording depth, range, and aspect with respect to the source. This means that the single airgun does not fully capture the complex propagation pattern of sound from a full array. On the other hand the propagation from the array is so complex that it requires sophisticated modeling validated by extensive measurements in order to predict what the whale will be hearing.

Since there are pros and cons for each kind of deployment, we propose to maintain the option of using either, but will prefer a full airgun array where possible, as this is the actual signal experienced by whales from commercial seismic survey. A full array may also be required to conduct playbacks at the higher range of exposure levels. The Bowles et al. (1994) and Mate et al. (1994) papers suggest that sperm whales may react to airguns at ranges of 50-300 km. Richardson et al (1995; fig 6.22) suggests that this would correspond to a received level of about 120 dB re 1 μ Pa, similar to, if not above, the levels at which Watkins and Schevill (1975) observed responses to impulse sounds from pingers. If we used a single airgun with a source level of 220 dB re 1 μ Pa at 1 m, then this airgun could easily achieve this received level at a range of 10 km or more. On the other hand our results from CEEs to four sperm whale last summer suggest minor responses if any, to exposures in the 143-148 dB re 1 μ Pa rms, at ranges of 7-16 km. If we assume spherical spreading, the observed patterns of received level with range are consistent with an effective source level of about 225 dB re 1 μ Pa rms from this array.

In our experience, it is difficult to maneuver a source vessel closer than 1 km from tagged sperm whales, and closing any closer makes it more difficult to predict range and therefore exposure. Sperm whales typically dive 700-900 m deep during foraging dives. If sperm whales show little response to the lower end of exposures and if we need to test responses to received levels near 180 dB re 1 μ Pa rms, then if we are to approach no closer than 1000 m from the subject, an airgun array would be required. Figure 2 below shows 0-P received levels measured at a depth of 1000 m at various ranges from a standard commercial airgun array used for seismic survey and for the smaller one used for our playbacks last year. This smaller array has lower levels of sound directed downwards, but actually slightly higher levels directed horizontally, because it is less directional. As noted above 180 dB re 1 μ Pa rms corresponds to 190 dB re 1 μ Pa 0-peak, so at a horizontal range of 1000 m from a diving whale, the expected received levels of 187-188 dB re 1 μ Pa 0-peak would be about 177-178 dB re 1 μ Pa rms, just below the maximum planned received level.

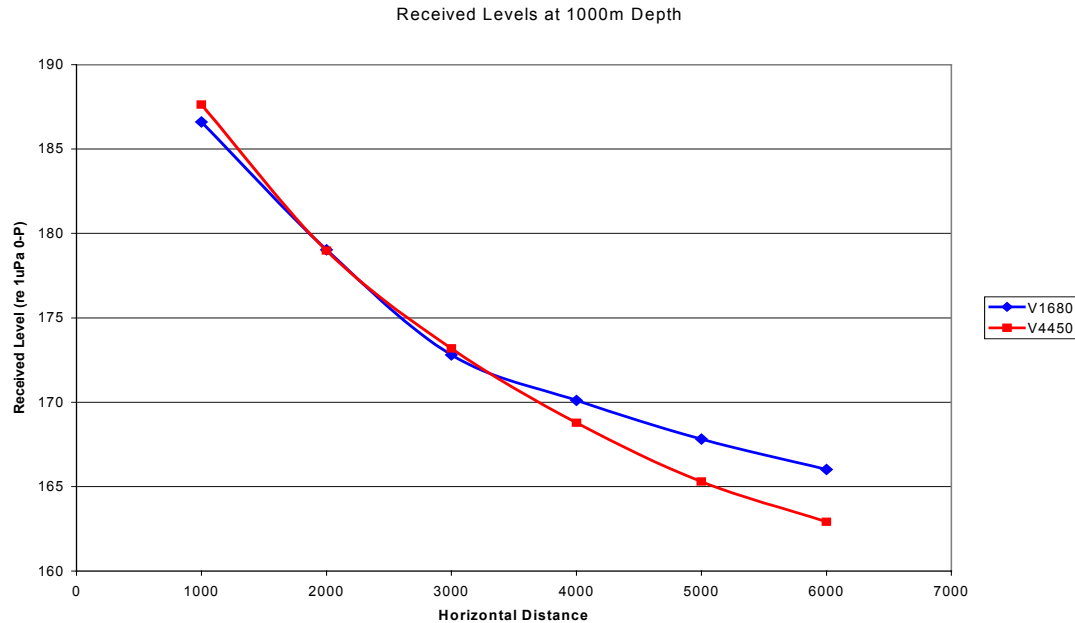


Figure 2. Decrease in received level of sound, measured from zero to the peak pressure, as a function of horizontal distance modeled for two different airgun arrays, one with a volume of 1680 cu. in., and the other one with a volume of 4450 cu. in. Figure courtesy of Philip Fontana, IAGC.

At the start of the cruise, we will usually conduct an engineering and calibration test to calibrate the sound sources. This is important to validate the models used to predict the received level of sound at the whale as a function of range and depth. For this preliminary engineering and calibration test, we will select an area with low density of marine mammals in a habitat where beaked whales would not be expected. We will only start transmitting after monitoring visually and acoustically for 30 min with no detections of marine mammals. The source level will be ramped up by no more than 6 dB every five minutes. This five-minute interval is usually used for ramp up of these sources, and it is important for the design of this experiment that our ramp-up procedure mirrors that used by industry. If any marine mammals are detected within the 180 dB zone, corresponding to 300-500 m for the maximum source level of 230 dB viewed with horizontal displacement, the source will be shutoff until none are detected for 30 minutes again. The basic plan for this test is to use a buoy or boat to deploy an array of calibrated hydrophones vertically in the water, then for the source vessel to run a pattern around the hydrophones. This allows us to validate precisely how sound is propagating from the source to be used in the playbacks.

The typical setting in which we conduct playbacks to sperm whales is when they are feeding and diving, often down for 40-50 minutes at a time. This diving behavior is often highly repeatable, which makes it a good setting for experiments in which we collect pre-exposure baseline data for at least one dive cycle. In this setting, it is seldom possible to estimate range to the nearest whale to a precision of a hundred meters, so we will typically try to set up an approach of the source vessel so that the closest point of

approach is far enough from the nearest whale to achieve our goal received level, while minimizing the chances that any other whales will be exposed to higher levels. During field work in the summer of 2002, we found that a range of 8-16 km yielded a received level at the whale of 143-148 dB re 1 μ Pa rms. At these ranges, any other whales within a kilometer of the tagged whale would experience very similar received levels, and there is little chance they will experience much higher levels. If the closest points of approach to give the goal received level requires approaching to near 1 km, we must ensure that we can accurately estimate range from the source to the whale(s). If we are using a system that can locate the range to clicking sperm whales as they dive (e.g. Thode et al 2002), we can conduct the closest point of approach of a playback at any point in the dive cycle. If we are not obtaining ranges from this passive acoustic monitoring, then another method to ensure accurate positioning is to time closest points of approach to diving whales soon after they have dived. Our visual observers use a well-tested technique for measuring the range to a surfacing whale. They measure the angle from the horizon to the whale on bigeye binoculars, which allows us to accurately estimate range. All playbacks will be conducted with a conservative pass-by, designed to ensure that whales will not be exposed to sound levels above the goals of the experiment.

As mentioned above, our measurements of received levels 10 km away from the airgun array used for playbacks, correspond to an effective source level at this horizontal range of 225 dB dB re 1 μ Pa at 1 m rms, which is close to the expected level from a single airgun. Closing to a range of 1 km should yield a received level of 165 dB dB re 1 μ Pa rms. However, arrays of airguns have a complex spatial pattern of sound propagation. They are designed to direct pulses of low frequency sound energy downwards, and little is known about horizontal propagation, especially at higher frequencies. In order to predict exposure at whales at or above the 160 dB re 1 μ Pa rms region, when the source vessel must come near a kilometer from the whale, we need sophisticated acoustic modeling, tested and validated by measurements of sound made near an airgun array. We are collaborating with ocean acousticians and experts in propagation from airgun arrays to develop this model, which will be operated on the ship at sea. The model will be validated by the calibration test and its predictions will be checked after each playback once received level data are downloaded from the tag.

We have followed tagged sperm whales during exposures of airguns at received levels in the range of 140-150 dB dB re 1 μ Pa rms and have not found obvious responses in preliminary analyses. We will aim to expose whales in the 150-160 dB range in the next cruise. If no response was seen at this point, the only way we could increase received level at the whale using this source would be by approaching the whale near 1 kilometer. At this close a range, estimating exposure at the whale requires more detailed models of sound propagation. Figure 3 shows the modeled propagation pattern from the airgun array used in our playback experiments last summer. It represents a vertical slice diagonal to the direction of motion of the source vessel.

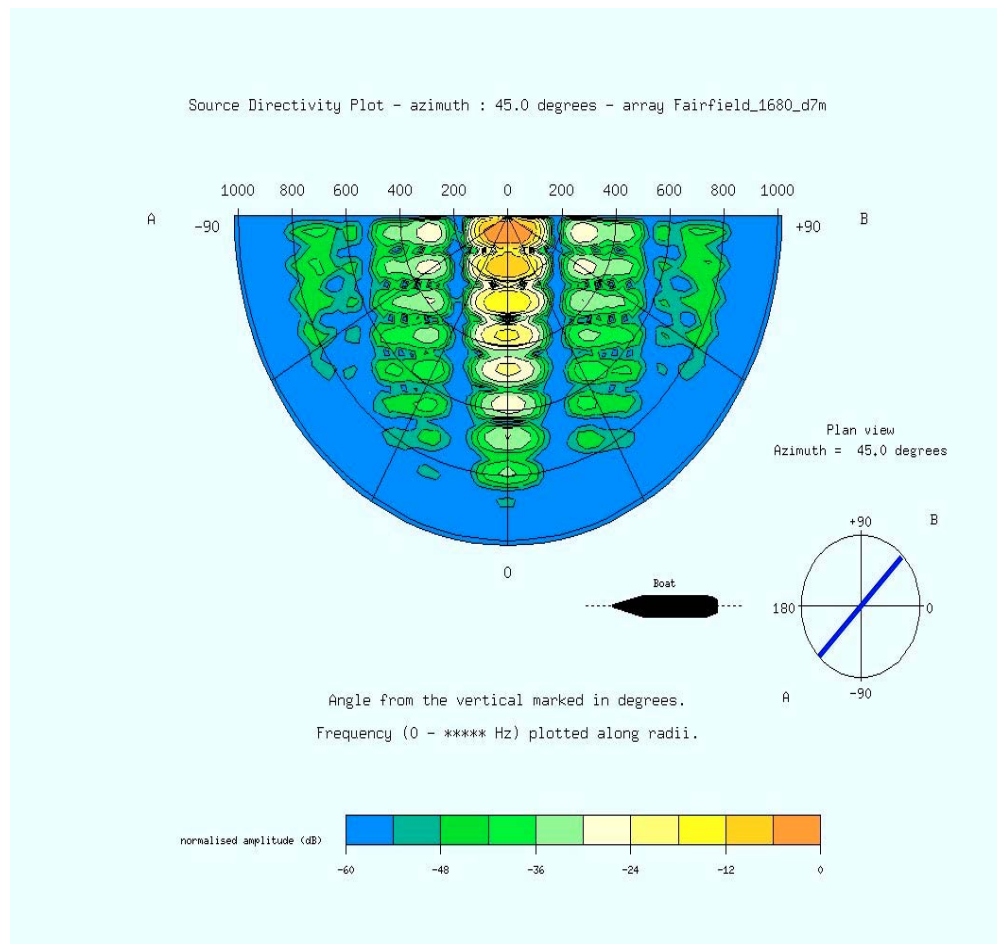


Figure 3. Modeled propagation of sound from the 1680 cu. in. airgun array used for playback experiments in the summer of '02. Space represents a vertical slice taken at a diagonal from the direction of motion of the ship. As a whale moves vertically or horizontally through this field, especially at any position offset from directly below the array, it will experience changes in received level of >20 dB over changes of 100 m. These changes are still present but less dramatic at greater ranges or either in line or abeam of the direction of motion of the ship. Courtesy Philip Fontana, IAGC.

Seismic survey vessels typically produce one pulse every 10-15 seconds for long periods of time, moving back and forth along straight survey tracks. This means that the typical sperm whale experience with seismic survey would involve hearing an airgun array operating at some range and low received levels for quite a while. If the survey line happened to come near the whale, the whale would then hear steadily increasing exposures. More rarely, if a whale was near a vessel at startup, it would usually hear the normal ramp up procedure, in which the vessel roughly doubled the sound energy, by increasing the number of airguns firing, every five or so minutes. Our playback protocol is designed to test responses to both of these kinds of exposure. We start the playback with a soft start ramp up procedure at a distance where the received level is well below

our goal maximum received level for the playback. Sounds will only be transmitted following a careful procedure. Visual and acoustic monitors will work for half an hour to see if any animals might be within the 180 dB re 1 μ Pa rms maximum exposure zone. If none are detected near this zone during the entire time, sounds will be started by operating a single airgun, and the source level will be increased by adding more airguns firing every 5 minutes until it reaches the maximum planned level involving the full airgun array. The ramp up procedure uses a longer interval for doubling than the whalefinding sonar, because this is the standard interval used by industry, and we should match this for our results on possible responses to ramp up to be useful for inferring effects of the industry protocol. It makes sense for this more intense source to use a longer interval as the final doublings occur at higher levels and thus increase the range at which whales might choose to avoid by enough to suggest a slower ramp up so whales have longer to avoid a particular exposure level. Then the source vessel moves on as straight as course as possible to pass by the whales at a range for closest point of approach corresponding to the goal maximum received level for the playback. The direction from which the source vessel approaches is planned so that the tagged whale(s) are those closest to the sound source if there are more whales present than those tagged. Visual and acoustic monitoring will continue during the entire transmission period, and these monitors will have the source shutdown if any animal comes near the maximum allowed exposure zone.

This playback protocol is designed to minimize chances of inadvertently exposing animals to levels above the maximum planned exposure level. At a 230 dB maximum source level for an individual airgun, an animal would need to be about 300 m away to be exposed to received levels above the 180 dB re 1 μ Pa maximum exposure for airguns. Figure 2 shows that for an airgun array of the sort we would use, the 180 dB re 1 μ Pa rms range would be less than 1 km of horizontal distance. Thus the highest planned exposures would involve pass bys at horizontal ranges of about 1 km. Of course, the precise propagation pattern of the specific airgun array used for the playbacks will carefully be modeled and measured, and all playback pass bys will be planned using these validated exposure predictions. In addition, the actual exposure of each tagged whale can be double checked after the tag is recovered, so we will have lots of confirmation of how well the plans are working before we might move in the playback series to testing these higher exposure levels. We will only conduct playbacks in conditions of good visibility and will keep a constant watch of at least two observers for at least half an hour before the playback, and we will be monitoring for cetacean vocalizations using a towed hydrophone array. By measuring the time delay between the direct path and surface reflection of sperm whale clicks, we have been able to estimate range quite accurately to diving sperm whales when they are clicking (Thode et al. 2002). If any animals other than the sperm whale subjects of the experiment are detected and judged to be at risk of coming within the range corresponding to the maximum 180 dB exposure level during rampup, we will postpone the start of playback. Visual and acoustic monitoring will continue during the entire transmission period, and these monitors will have the source shutdown if any animal comes near the maximum exposure zone. We will position the playback vessel to be closer to the tagged whale(s), which are the focal subjects, than other sperm whales that may be in the area, and we will conduct any approach to minimize closer approach to other whales. The tagged subject playback protocol is as

follows. Focal whale subjects will be tracked using visual observation, passive acoustic tracking, and sighting of DTAGs and monitoring the radio transmitter on the Dtags when possible. Once a whale is tagged and photo-identified by the tagging vessel and the tag is secure on the whale (see below for kinds of data recorded during tagging attempts), it will be identified as a focal animal. We may tag one or more other whales simultaneously. If so, we try to track all of them as focal animals. At least one full surfacing and dive sequence will be monitored before playback starts. If the focal whale(s) is not engaging in long dives, a pre-exposure period of 40-60 min will be conducted before any playbacks begin. We will attempt to have whale observers and tag trackers blind to the playback timing and condition. Playbacks will be conducted with the PBV moving towards the focal whale at a speed of about 3-8 km/hour. Typical speeds for commercial seismic vessels are 3-5 knots; we will typically operate the source vessel within this range, but may want to move more slowly to move over the appropriate distance in the appropriate time. If the playback vessel approached from a range of 10 km, this would yield an approach interval of just over an hour at the 8 km/hr speed. The PBV will plan its approach to pass within a predetermined distance from the subject(s), then pass the whale(s) before ceasing the playback. Every attempt will be made to monitor the behavior of the tagged whale for at least 40-60 min post approach.

A critical element of the design of our experiments is to have roughly equal data sets on the behavior of the tagged whale before playback, during playback, and after playback. This allows each individual's pre-playback behavior to serve as its own control. This is critical for cases where behavior of one individual may be quite consistent over several hours, but may differ from other individuals at other times and places. We often obtain tag retention times of 6-12 hours, allowing for two pre-exposure dives over two hours, two exposure dives over two hours, and at least two hours of post-exposure observations. If responses are seen, we will design later tests to optimize our chances for observing complete return to baseline behavior.

4. Removing a Marine Mammal from the Wild – N/A

5. Taking of Marine Mammal Parts or Specimen Samples

As described above, the only tissue samples to be taken from marine mammals involve the collection of skin that may adhere to the tags. When tags are recovered, we will carefully inspect for any sloughed skin that may have adhered to the greasy coating of the suction cup used for attaching the tag. Any such skin will be collected for genetic analysis (Amos et al., 1992). Thus the maximum number of samples would equal the number of tags deployed for each species as indicated in Table 6. Skin samples from beaked whales will be sent to Merel Dalebout, a PhD student of C. Scott Baker at the University of Auckland in New Zealand, looking at molecular systematic relationships and species diversity in beaked whales. Her analysis may be necessary in some cases for species identification, and will help in her research on genetic analysis of population structure of beaked whales. Skin samples of sperm whales will be made available to Daniel Engelhaupt of the University of Durham, U.K. We would offer to send skin samples from other species where the analysis is not necessary for our own project to the National Marine Mammal Tissue Bank.

6. Import/Export of Marine Mammals/Marine Mammal Parts

a) The country of exportation, country of origin, export destinations:

Table 14. List of countries for import/export of skin samples

Species	Part for import/export	Import: Country of Origin and Exportation	Export destination country
Fin whale (<i>Balaenoptera physalus</i>)	Skin sample	Italy, Spain	U.S.
Sperm whale (<i>Physeter macrocephalus</i>)	Skin samples	Italy, Spain	U.S., U.K.
Dwarf and pygmy sperm whales, (<i>Kogia</i> spp.)	Skin samples	Italy, Spain	U.S.
Beaked whales (<i>Ziphius</i> , <i>Mesoplodon</i> spp.)	Skin samples	Italy, Spain, United States	New Zealand
Pilot whale (<i>Globicephala</i> spp.)	Skin samples	Italy, Spain	U.S.

The species designated for import/export of tissue are limited to baleen whales, sperm whales and the taxa where visual observations often cannot resolve species ID: *Kogia*, beaked, and pilot whales.

b) A description of how the marine mammal part/product to be imported were taken in the country of origin.

Table 15. How parts for import are to be collected:

Species affected	Part collected
Fin whale, Beaked whale (sp.), Pilot whale (sp.), <i>Kogia</i> (sp.), Sperm whale	Skin samples collected from skin sloughed with suction cup tag

c) Statement and documentation of the status of collected materials.

None of the collected materials will involve capturing an animal. They will be very small samples of sloughed skin that are byproducts of the tagging or that may be seen floating in the water and collected with a dip net near where a whale surfaced. We propose tagging research in the Mediterranean operating from the port La Spezia in Italy and in the North Atlantic. The areas where tagging is anticipated most immediately for project 1 is off the eastern coast of the US, in the Mediterranean, and off the Canary Islands. Any

samples will include documentation concerning how the sample was taken, and all samples will be taken and held in compliance with the laws of the country of exportation. For example, killing, capturing, harassing, holding, disturbing reproductive and resting areas, and the trading of a cetacean or any of its parts is forbidden in Italy (Law 19.12.75, n.874; D.M.M.M. 21.05.80, D.M.M.M. 03.05.89, Law 5.10.81, n. 503; Law 25.01.83, n.42; Law 7.02.1992, n. 150; DPR 9.09.97, n. 357). Italy has laws against trading parts of a cetacean, but non-commercial samples can be exported for scientific research. The project in the Canaries Islands is a cooperative project with Spanish biologists, and any disposition of samples will be coordinated with Spanish biologists and authorities. We would offer to send skin samples from species where the analysis is not necessary for our own project and for our collaborators to the National Marine Mammal Tissue Bank.

7. Research on Captive Animals -- N/A

8. Background and Review of Research

a) Background

Over the past 50 years, economic and technological developments have increased the human contribution to ambient noise in the ocean. Shipping is the overwhelmingly dominant source of manmade noise in the ocean (Green et al., 1994); it is reported to have increased ambient noise levels in the oceans by 10 dB from 1950 to 1975 (Urlick, 1986). A wide variety of artificial sound sources could also affect marine mammals, including explosive sources, ship noise, sonar, seismic exploration, and acoustic telemetry. Loud low frequency sound sources are increasingly being employed for long range sonar, research, and communication in the sea. The oil industry studies geological formations deep below the sea surface by using arrays of airguns to make sounds so loud that echoes of geological strata can be detected kilometers away. Typical peak-to-peak source levels for the pulses produced by air gun arrays used for seismic exploration range from 235- 269 dB re 1 μ Pa peak-peak at 1 m with pulse durations of several tens of milliseconds repeated every 10 sec or so (Richardson et al., 1995). Military sonars have had high source levels in the region of 230-240 dB re 1 μ Pa peak-peak at 1 m since World War II (Urlick 1983).

There is growing evidence that man-made sounds can disturb marine mammals, and the issues concerning the effects on marine mammals of man-made sound have received increasing attention (Green et al., 1994; Richardson et al., 1995). Observed responses include silencing, disruption of activity, and movement away from the source (Chapter 9, Richardson et al., 1995). The zone of influence of a sound source depends upon its level, its frequency spectrum, and upon the conditions for sound propagation near the source (Chapter 10, Richardson et al., 1995). Sound carries so well underwater that animals may be affected many tens of kilometers away from a loud acoustic source (Finley et al., 1990, Cosens and Dueck, 1986), and there is no *a priori* reason to rule out effects at even greater ranges. Marine mammals rely on sound for communication, orientation, and detection of predators and prey; disruption of any of these functions would interfere with normal activities and behavior.

We have three primary areas of interest for the research involved in this permit. Project 1) The behavioral ecology of free-ranging marine mammals. This project involves using DTAGs to study animals under baseline conditions. The data will be used to

document diving patterns, location and timing of vocalizations, and will have a special focus on deep-diving toothed whales. It also is important for understanding the impact of manmade noise on marine mammals. If we are to infer the biological impact of any behavioral disruption to noise, we need to know the function of the acoustic and motor activities in which the animal is engaged. Sound can play a major role in the lives of marine mammals; for example, it is useful for navigation, detection and localization of prey, and for mediating social interactions. How wild animals use sound is important both from the perspective of basic research as well as providing an indication of the potential impact(s) of anthropogenic noise. In particular, studying the effect of disruption of vocal behavior requires an understanding of the communicative or sonar function of the vocalizations. The DTAG is a very powerful technique for combining behavioral and physiological data along with recording the sounds an animal makes and hears. This makes the DTAG an excellent tool for behavioral ecological study of sound use in marine mammals. Project 2) Use of the DTAG to validate methods to determine presence of marine mammals. Most policy to protect marine mammals from noise involves ceasing to transmit if an animal is within a certain zone. This requires monitoring for the presence of animals. Both passive and active acoustic methods have been proposed, but require ground-truthing. The DTAG offers benefits for ground truthing vocalization rates for passive methods (e.g. Mathews et al. 2001) and Target Strength for active methods. Project 2 under this permit involves validating an active whalefinding sonar. The DTAG is additionally well suited to measuring possible responses to this active detection system. Project 3) The response (acoustic and behavioral) of wild marine mammals to controlled exposures of anthropogenic noise. To test questions related to this area either the animals can be observed (i.e. with DTAGs and surface observations) in critical areas (e.g. shipping lanes), or animals (ideally with tags to follow subsurface behavior) can be subjected to playbacks of actual noise sources or electronic reproduction of pre-recorded noise sources. We propose to emphasize the latter approach of controlled experimental studies that are better suited to studying causation and allow for a more precautionary and controlled plan for acoustic exposure. The primary methods we propose to bring to bear to this problem included using acoustic recording tags to record stimulus and responses of tagged whales to experimentally controlled exposures of noise.

b) What will be done to meet the research objectives

(1) Kinds of Approaches and Follows

Close approach (CA) – A close approach is defined as any approach to a single focal animal within 10-15 m to allow for tag attachment and/or photo-identification. Animals need to be approached to within 10 m for tag attachment. This will be done in a way to minimize disruption: slowly, deliberately, and for as short a time as possible.

Focal Follow (FF) – Following a single focal animal (typically the tagged animal) or several tagged animals during the tagging to observe surface behavior directly, to relate data on the tag to observed surface behaviors, and for a period of time before the tag is attached and after the tag releases for the animal to determine any effects of tagging on behavior. These focal follows are typically conducted from 100-500 m from the animal, when in a small boat, or up to 1-2 km from a large vessel, depending on weather conditions and visibility from the observation vessel.

Playbacks (PB) – Playback experiments are proposed for two different settings: sperm whales in the Gulf of Mexico and several different species, again with an emphasis on sperm whales, in the Mediterranean Sea. All of these playbacks will use underwater speakers or airguns deployed from a vessel. There will be one or several designated focal animal subjects for each of these playbacks, depending upon how many animals are tagged, which will only occur after baseline behavior of the subject(s) has been collected. During a playback, the playback vessel may maneuver to stay within a kilometer or so of the focal animal, but the vessel will attempt to stay far enough from the focal animal so that the visual stimulus of the ship or source cannot be sensed by the subject. This constraint sets the required source level for a particular desired received level at the animal, since there is about 50 dB of transmission loss to a range of 317 m. The playbacks follow a protocol to minimize the chances that non-focal animals will be exposed to received levels above that of the focal. Playbacks will typically last about one-three hours, after which either the playback or a different tracking vessel will follow the focal whale in order to collect post-exposure control data.

(2) Sound playback experiments or Controlled exposures of noise

Two different kinds of research have been used to study disturbance reactions: observations of opportunistic exposures and experimental playbacks of sound stimuli. The former provides the most realistic circumstances for a ‘natural’ experiment, but leaves many factors uncontrolled. Controlled experimental exposures of noise (these are more commonly called “playbacks” (McGregor, 1992), but playbacks typically involve more emphasis on natural sounds and tend to use artificial sounds only as control stimuli) allow similar exposures to be repeated with different subjects. Having a standardized experimental exposure that can be repeated allows one to pool data from different subjects, enabling statistical analysis of responses. In addition, experiments are much better suited than correlational studies to determine whether sounds actually cause behavioral responses (Gisiner, 1998).

Since the whales in these studies are responding to sound stimuli, when considering factors that may affect response, it is critical to focus on features that will be salient to the animals, features such as the loudness, frequency, duration, location, and motion of the sound source. Carefully designed controlled exposures can reveal stark differences in response to sounds with different features. For example, Malme et al. (1983, 1984) demonstrated that 50% of gray whales migrating past the central California coast avoid continuous sounds at received levels of near 120 dB re 1 μ Pa rms, but avoided the sounds of airguns at received levels of near 170 dB re 1 μ Pa (average pulse pressure level), a 50 dB difference. In the same setting, Tyack and Clark (1998) showed that avoidance responses of migrating gray whales scale with received level for a sound source placed in the migration corridor, but this response disappeared when the source was placed offshore, even for received levels 20-30 dB above levels that elicited avoidance from the inshore source.

The basic goal of the controlled exposure experiments or playbacks covered in this permit is to determine the lowest exposure of transient transmissions of sound with received levels between 120 and up to 180 dB re 1 μ Pa for airgun signals up to 160 dB re 1 μ Pa for all other signals that predictably elicits responses of whales. Our studies are designed in such a way as to minimize exposure of animals to sounds louder than is

required to elicit any responses in this range of received levels. The primary feature we control in our experiments is the received level of sound at the test subject, and we will model or measure sound propagation in order to predict and control exposure at the animal. In the past few years we started each playback with a source level yielding a relatively low received level at the whale subject, e.g. a level of 120 dB re 1 μ Pa rms. After we had time to monitor for potential disturbance, the goal received level was increased by 10-20 dB. For the whalefinder sonar, our most current experiments have tested responses of whales to maximum received levels of sound in the 140 dB re 1 μ Pa rms region and for the airgun studies, 143-148 dB re 1 μ Pa rms. The received level at the whale will be increased either by increasing the source level or by having the playback vessel approach the subject.

(3) Maximum received level for controlled exposures of noise

The basic goal of the playback experiments is to determine behavioral responses of whales exposed to received sound levels well below those thought to pose a potential for injury. The range of sound exposures has been selected to include those that are currently viewed by regulatory policy as unlikely to pose an adverse impact. The playback research is designed to test these assumptions. The basic criterion for maximum received level for the whalefinder sonar involves using a sufficient signal to receive echo returns from the whale, while not posing any risk of adverse effects.

The most important criterion for our selection of a maximum exposure level involves our concern not to expose animals to sounds that might cause physiological harm or injury. We recognize that there may be some circumstances where animals will remain in areas with no obvious sign of behavioral disruption, even though the sound exposure may affect their hearing. Therefore one cannot always rely upon wild animals to swim away from a source to avoid potentially harmful exposures. Over the past few years there have been several successful experiments defining sound exposures that cause temporary shifts in the threshold of hearing in captive dolphins and seals (Ridgway et al., 1997; Kastak et al., 1999; Schlundt et al., 1999). We advocate using TTS as a signpost indicating that exposures below those that cause TTS are likely to be safe in the sense that they will not cause injury. The primary features we will control in our experiments are the duration and received level of sound at the test subject, and we will model or measure sound propagation in order to predict and control exposure at the animal. We will establish a maximum received level above which we will not expose animals in order to avoid exposures that might enter the range of possible harm to the auditory system. One important feature used to help set this level involves the duration and duty cycle of the signals. For exposure to brief impulses from airguns, and short sonar signals with low duty cycles of the sort to be tested in these studies, the TTS studies suggest that a maximum exposure level of 180 dB re 1 μ Pa is conservative. Ridgway et al. (1997) and Schlundt et al. (1999) found no sign of TTS in dolphins exposed to received levels of single 1 sec signals above 190 dB re 1 μ Pa for sounds at frequencies of best hearing for the dolphins that were longer in duration and narrower in bandwidth. The onset of TTS started at received levels above 190 dB for these sounds lasting one second.

Given that our exposures will be below the level indicating a potential for injury, we also take into account the regulatory situation. The High Energy Seismic Survey (HESS, 1999) suggests a threshold of potential impact for the sounds of airguns used in

seismic exploration of 180 dB re 1 μ Pa. The SURTASS LFA FEIS (Department of the Navy 2001) assumes a continuum of risk from low near 120 dB to high near 180 dB, with an assumed take for all exposures above 180 dB. In this policy context, NMFS OPR in its cover letter of 25 July 2001 for the first amendment to permit no. 981-1578, quoted comments from the Marine Mammal Commission pointing out how important it is to test whether exposures to received levels up to 180 dB re 1 μ Pa may cause disturbance:

The experimental protocol uses a maximum received level for all sounds except airguns of 160 dB. However, this upper limit is not consistent with that proposed by the Navy (i.e. 180 dB). The difference in these limits seems significant (a hundred-fold change in the intensity) and an informed judgment on the effects of SURTASS LFA or similar systems requires a measure of response to these levels. If a received sound level of 160 dB or less is sufficient to cause significant behavioral changes, then the need to increase the received level to 180 dB is not apparent. However, if changes observed at a received level of 160 dB are deemed insignificant, then further testing at higher levels seems necessary.

We will establish a maximum received level above which we will not expose animals in order to avoid exposures that might enter the range of possible harm to the auditory system. For the relatively short sound transmissions we propose, with durations less than 0.5 sec and less than 3% duty cycle, we believe that a maximum exposure level of 180 dB re 1 μ Pa rms is conservative based upon TTS data. One of the regulatory guidelines concerning commercial use of airguns in the Gulf of Mexico involves limiting exposure at or above 180 dB re 1 μ Pa (NMFS 2003). Given the extensive data showing avoidance responses of both baleen and toothed whales to airguns including reasonable fractions of the population at received levels near 170 dB (Malme et al. 1984; Stone 2001), and given the current regulatory situation in the Gulf of Mexico, we propose a maximum exposure level for airgun signals of 180 dB re 1 μ Pa rms. Given the diversity of responses of marine mammals to sonar signals, and given the extensive data we still need to gather in the 140-160 dB re 1 μ Pa rms region, we propose a maximum exposure level of 160 dB re 1 μ Pa rms for signals from the whalefinding sonars and coda playbacks. We will also add a margin of error for safety in each experiment to account for the possibility that the acoustic models used to predict received level at the animal are not always correct. This margin of error will be validated by comparison of estimated levels with those measured initially during the engineering test, and during the course of the playbacks by levels measured at the whale by the tag.

If granted a permit that specifies a maximum exposure of 180 dB re 1 μ Pa rms for airgun sounds, and 160 dB re 1 μ Pa rms for other sounds, our studies will be designed in such a way as to minimize exposure of animals to sounds louder than is required to detect echoes in the case of the whalefinder sonar, or to elicit any responses deemed significant in this range of received levels in the case of the airgun playbacks. The primary feature we will control in our experiments is the received level of sound at the test subject, and we will model or measure sound propagation in order to predict and control exposure at

the animal. In the past few years we started each playback with a source level yielding a relatively low received level at the whale subject, e.g. a level of 120 dB re 1 μ Pa rms. After we had time to monitor for potential disturbance, the goal received level was increased by 10-20 dB. Both for the whalefinder sonar and for the airgun studies, our most current experiments have tested responses of whales to maximum received levels of sound in the 140 dB re 1 μ Pa rms region.

The received level at the whale will be increased either by increasing the source level or by having the playback vessel approach the subject. The time devoted to the period for each received level must be a compromise between giving the animal time to show a response and for us to detect it, while allowing the playback, which will typically last about one hour, to complete the range of exposures up to the goal should no response be observed. For the whalefinder sonar tests, we propose our next series of tests to have a goal maximum level in the 130-150 dB region, since no echoes and little response has been detected to the 120-140 dB range of previous tests. Since little response has been detected to the 120-140 dB range in initial playbacks, we propose a maximum received level for airgun playbacks in project 3 in the 140-160 dB re 1 μ Pa rms range for our next series of playbacks, the received level at which some avoidance responses to airguns have been detected in baleen whales (Richardson et al., 1995).

9. Lethal take – NA: No lethal take

No unintended mortality is possible.

No known unintended mortality has arisen from similar tagging or playback activities and none is expected in the research covered under this permit. The tag attachments we are using have been used extensively with no evidence of injury or any problem other than behavioral disruption to the tagged whale in some species (Schneider et al., 1998). The playback experiments will carefully control the received level at the whale to avoid the potential for minor injury to the auditory system or other injury of any kind. The playbacks are designed to define the minimum exposure required to elicit behavioral responses. They will start with low levels of exposure at the subjects and will not increase the exposure level if behavioral responses have been detected, until those responses are fully analyzed. The previous three years of research conducted under permit no. 981-1578 and other playback experiments using similar stimuli have been conducted with sperm whales with no problems (Gordon et al., 1996). The behavioral reaction most commonly reported for sperm whales exposed to brief manmade sounds is cessation of vocalization (Watkins et al., 1985; Bowles et al., 1994). This vocal behavior will be monitored in real-time, and playbacks will cease if whales show an unusual cessation of vocalization so that we can determine how long it takes the whales to return to normal vocal behavior. The tags will allow us to follow individual whales after playback to verify normal behavior.

Increasing evidence suggests the potential for prolonged exposure to intense sounds in some settings to cause beaked whales to strand, and some of the stranded animals may die (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998). Most of the reports on this problem correlate the strandings with naval maneuvers in which military sonars that operate at source levels of 230+ dB are operated intermittently for many hours in the mid frequency band (D'Amico, 1998; Evans and England 2001). The dominant species in these strandings is Cuvier's beaked whale, *Ziphius cavirostris*, but *Mesoplodon*

is often also involved, and there is at least one case involving several *Kogia* (Simmonds and Lopez-Jurado, 1991). In addition, there is one report that a stranding of two *Ziphius* occurred in the Gulf of California when a seismic vessel was operating tens of km away (Malakoff 2002). In spite of the hundreds of thousands of miles of seismic survey run in the Gulf of Mexico every year, no such stranding of beaked whales has ever been associated there with seismic survey operations. Given a rate of 0 mass strandings of beaked whales in millions of survey miles, the probability of any such risk with the 200 miles or so of airgun transmissions to be done annually in project 3, in an area with heavy levels of commercial seismic survey, is effectively zero. The risk of any impact from the controlled exposure experiments in the Gulf is lower than the same duration of commercial survey, because all of the controlled exposures will be conducted with a large team of highly trained observers, and the source will be shut down if any beaked whales are sighted. Because of the apparent heightened sensitivity of beaked whales to sonar, for playbacks under project 2 in the Mediterranean, we propose not to conduct playbacks to the genus *Kogia* and beaked whales of the species *Ziphius cavirostris* and *Mesoplodon densirostris*. We will avoid known *Ziphius* habitat, which is well studied in this region (Figure 1), monitor carefully for these species, and shutdown if any are sighted at any range from the source vessel. The geometry and timing of source vessels and the beaked whale strandings suggests that animals could have been as far as a few tens of km from the source vessel for an exposure that was related to the stranding. In the two cases where the acoustic propagation has been measured, this is consistent with an exposure of above 160 dB re 1 μ Pa (D'Amico, 1998; Evans and England 2001). The maximum range out to 160 dB is only 317 m for the whalefinding sonar sound source operating at its maximum source level. If we take a potential exposure range of 30 km for the military sonars, then the area affected at levels above 160 dB is 0.28 km² for the whalefinder and 2827.43 km² for one military sonar. In addition to the area affected being 1/10000 the size, another critical factor is duration of exposure. As the military ships moved through beaked whale habitat, the whales could have been exposed to levels above 160 dB for hours, and may have been unable to swim short distances horizontally to avoid exposure. In the case of the 317 m radius for the whalefinding sonar, if the ship is moving at 8 km/hr, a whale in the path of the ship would be exposed for less than 5 min, even if it were at the surface and not moving. As the ship approached, the whale could avoid this exposure by swimming away from the course of the vessel. The whalefinder sonar has power levels and frequency ranges very similar to depth sounding and bottom profiling sonars, which are deployed in the hundreds of thousands, with no evidence of adverse effects. Unlike military sonars, depth sounders, and fish finders, the whalefinder is ramped up, allowing any animal close by ample opportunity for horizontal avoidance at start up. In addition, the dive record we have obtained for *Ziphius* indicates a dive to 450 m. At this depth, a diving whale would not be exposed to levels of 160 dB, even if the ship passed directly overhead. Therefore, the combination of lower source level, selection of location, and monitoring and mitigation measures reduce the odds of any incidental harassment takes for these species in project 2 to as low as we can make it, and lead to the conclusion that there is a higher possibility of lethal take from the ship colliding with a whale than from exposure to sound.

10. Research on Endangered Species

For endangered (ESA) or depleted (MMPA) species, why proposed research cannot be conducted using an alternate stock. How will expected research results benefit the stock.

A major goal of this research is to determine how animals thought to be vulnerable respond to manmade noise, which is pervasive in their environment. The playback experiments involve controlled exposures that are less frequent and lower in level than many of these species may face from commercial sources. The maximum level of exposure is lower than or equal to the exposures restricted by regulation. If this research helps in the formulation of regulations improving the protection of ESA or MMPA species from noise exposure, then this will help the stock benefit as individual animals are protected by monitoring and mitigation measures and as acoustic habitat degradation is reversed. In this context, it is essential to work with those species thought to be most sensitive. It would not be conservative to develop a policy based upon data from less sensitive species and then apply it to more vulnerable ones.

This same logic can be applied to age classes within a population. Dependent sperm whale young may be seen as a particularly vulnerable component of the population. Whitehead (1996) points out that calves may remain near the surface as adults dive. Adults are reported to stop clicking in response to manmade noise. If adults fall silent when a playback starts, juveniles might not be as effective at keeping contact with members of their group. This concern highlights the importance of attending to these potentially most vulnerable members of a population that are likely to be affected by manmade noise. We will pay particular attention during our playbacks to any silencing responses and visual observers will pay particular attention to sighting and following any young sperm whales in a group. Following the principle of special monitoring of vulnerable elements of a population, we will not tag young calves, but if we are easily able to tag juveniles with no more than minor responses from any of the whales, we propose to do so in order to test whether their own behavior is affected or whether they are affected by changes in the behavior of the adults around them.

D. Describe the Anticipated Effects of the Proposed Activity

1. Effects on Individual Animals

The tagging of whales in project 1 may evoke short behavioral responses such as sudden movement, turning or rolling. The longest effect of tagging we have been able to detect comes from tagging sperm whales that are breathing at the surface following a foraging dive. Once a tag has been attached to a whale, it may stop its blow sequence and dive more early than it would otherwise have done. The subsequent foraging dive involves normal diving, foraging, and vocalization behavior, but may be somewhat shorter than the previous or following dives, when the whale blows at the surface for as long as it wants. This change in dive duration does not appear to have an effect beyond an hour, and appears to have minimal effect on foraging. The goal of the whalefinder sonar test is to detect echoes from marine mammals while inducing as little reaction as possible. The tag is able to monitor for reactions. None have been defined in previous tests, other than possible orienting responses (Malakoff 2000), and we do not anticipate any effects on individual animals beyond this kind of short orienting response. The goal of the playback

experiments with airguns is to determine what levels of sound exposure may elicit disturbance reactions during and/or after a controlled exposure of a series of short (< 0.5 sec duration) transient sounds with $< 3\%$ duty cycle. The entire exposure series is designed to last up to one-three hours. The experiments are designed to detect changes in behavior lasting up to several hours during this exposure, and to monitor return of behavior to baseline after the exposure stops. Over a series of different research cruises, sound exposures will gradually be increased until they elicit reactions at least during part of the playback or until they reach the maximum planned exposure of 180 dB re 1 μ Pa rms for airgun signals. If reactions are detected that last beyond the post-playback tagging duration, then we will stop playbacks and reevaluate the design. Thus, it is unlikely given the design that individual animals involved in the experiments would have their activities disrupted by more than a few hours. These experiments are designed to evaluate unknown risks of uncontrolled sound exposure, but the careful control built into the experimental design will minimize the risks of the controlled sound exposures. The tagging and playback experiments use standard experimental techniques that have been used safely with many species over the past decade under NMFS permits. Given the large scale of these studies, the proposed combination of tagging and playback is not likely to be adopted by many other researchers.

2. Effects of Incidental Harassment

It is possible that close approaches of one animal for tagging might affect the behavior of other animals nearby. In previous tagging experience, we have seen few responses other than animals in the same group as the tagged one following the tagged animal if it turns or dives after tagging. We do not anticipate reactions lasting more than a minute to these incidental approaches. Similarly, when we follow a tagged whale, the follow vessel will also follow other animals nearby. The protocols for focal follow are designed so that the follow vessel has no effect on the behavior of either the focal animal or its companions, so we anticipate no harassment from this activity. The primary activity that might cause incidental harassment involves the playback experiments. These experiments are designed to maintain the focal animal subject closest to the source vessel, so that it will be exposed to the highest received level. However, it is possible that other animals might come close enough for the possibility of disruption of behavior. Not every species has been studied with the signals used for the playbacks, but enough is known to base some predictions. Baleen whales may avoid pulses from airgun arrays at received levels of about 170 dB re 1 μ Pa and ranges up to about 10 km (Malme et al, 1983, 1984, 1985; McCauley et al., 1998). Many dolphin species show little reaction to operating airguns, but some may show behavioral effects within a range of about 1 km (Goold and Fish, 1998). Captive bottlenose dolphins do not show aversive reactions to 1-sec tonal signals until they are above 180 dB re 1 μ Pa (Schlundt et al. 2000). This would correspond to a range of no more than 1 km from an airgun array and less than 100 m from the whalefinder sonar. Rendell and Gordon (1999) recorded pilot whales in the presence of 0.17 sec pings from a 4-5 kHz sonar. The pilot whales vocalized more often during transmissions, but did not avoid the area during several hours of exposure. Humpback, fin, and right whales have been reported to respond to sonar sounds in the 15 Hz – 28 kHz range (Watkins, 1986), and Maybaum (1993) reports that humpback whales

responded to pings from a 3.3 kHz sonar by swimming away with increased speed and linearity, but the sounds did not consistently affect vocalizations or diving behavior.

These observations suggest that baleen whales may show some avoidance behavior to airgun or sonar sounds, which is likely to limit the received levels to which they are exposed. However, since this avoidance does not appear to be accompanied by disruption of other behaviors such as diving or vocalization, and since the exposures and responses would be limited to a few hours, these changes in behavior may well not rise to the level of harassment. In spite of this low probability, this application requests harassment takes for each of the baleen whale species that might be in the vicinity of playbacks. The observed responses of odontocetes to airguns and sonar appear to be limited to a range of between 100-1000 m, a range within which they can be monitored visually by the visual observers who are always on watch before, during and after transmissions. Any changes of vocal behavior, such as that reported for pilot whales, can be detected by the acoustic monitors.

We request takes under this permit by incidental harassment for any of the species that may be present in the two study sites where playbacks are proposed – the Gulf of Mexico and the Mediterranean Sea, and we will use our visual and acoustic monitoring to document any incidental disturbance reactions. Transmissions will be shut down, however, if any marine mammals are detected to have the potential to approach within 180 dB re 1 μ Pa rms for airguns or 160 dB re 1 μ Pa rms for other sounds.

3. Effects on Stocks

The proposed research will have only minor short-term effects on the individual subjects. The playback experiments will only be detectable over a tiny portion of the seasonal range of the species present in the study area. Therefore, the proposed research will have little direct impact on the relevant species or stock. Since most of these species are now exposed to much more frequent and higher level sound exposures, any information verifying safe exposure levels will be critical for ensuring adequate protection of these stocks from impacts of human-made noise. If the proposed carefully controlled noise exposures do indicate any effects, the data will be critical for establishing evidence for exposure criteria for possible regulation that may cause a cumulative decrease in exposure from existing activities, which are not currently effectively regulated.

4. Stress, Pain, and Suffering

This project is designed to minimize the chances of any stress, pain or suffering. Our tags are non-invasive, using soft suction cups, and there is no indication that they cause any pain. If they bother an animal, it can easily shake off the tag by rolling or shaking movements. A minority of tagged animals do this, usually within a few minutes of tagging. The ease and speed with which they can remove the tag if they are sensitive to it, indicates little chance for stress from attachments. In humans, the threshold for pain from acoustic exposure is above the level that can cause hearing damage. This project is designed not to expose any animals to levels high enough to cause even temporary changes in hearing, much less any hearing damage, and this criterion is more stringent than that for pain. Animals can easily avoid exposure during the playback experiments by swimming away, and if any such avoidance reactions are observed, subsequent exposures

will be carefully designed to take this into account. Each approach for tagging only lasts a few minutes, and we do not approach any individual more than three times a day. The follow and acoustic exposures are designed only to last several hours maximum, so are unlikely to have any longer term impacts. We follow the playback subjects after exposure to monitor for return to baseline behavior, and we will modify the playback protocol if there is any evidence for longer term changes.

a) IACUC review of similar research

The WHOI IACUC has reviewed the research projects that involve either tagging or the playbacks proposed here. All of these tagging and playback activities have been approved as posing low levels of risk and high levels of gain to the populations involved. This project will only be undertaken in accordance with the IACUC review.

5. Measures to Minimize Disturbance

a) Necessary vs. unnecessary disturbance

The proposed research uses tags to continuously monitor the behavior of cetaceans. This technique requires close approach for photo-identification and for tag attachment, and these close approaches and tag attachments may require some brief disturbance, but the tagging reduces the potential for disturbance during the subsequent focal follow. Focal follows of tagged whales can be conducted much farther from the focal whale than would otherwise be required to monitor the behavior of untagged animals. The goal of the focal follows is to operate the observation vessel in such a way that it has no effect on the subjects. This reduces the potential for disturbance after tagging.

Project 2 involves testing a whalefinding sonar. The goal for designing this kind of sonar is to maximize the potential for detecting echoes from an animal while minimizing the potential for disturbance. The source level required of the sonar and the received level required at the animal are basically defined by how well the sonar is working. Our initial cruises and tests involved low power and low received level at the animal. Unfortunately, we have not detected echoes from sperm whales, so must increase the source level of the sonar and the goal received level at the animal. At the same time that we are testing the sonar, we are also carefully monitoring for behavioral reactions, and we will not increase the exposure to animals beyond that at which reactions are predictable, until these are fully analyzed and reviewed.

The playback studies are designed to determine what kinds of sound exposure may cause behavioral disturbance in marine mammals. Marine mammals are exposed to an increasing number of loud sound sources. One of the main obstacles to minimizing the risk of adverse impacts of these exposures concerns our ignorance of sound levels that may cause disturbance. We will therefore intentionally expose animals to relatively low received levels of sound in order to test whether the exposure disrupts their activities. All of this research takes place in a broader policy context, in which interest and concern may focus on specific exposure ranges for specific taxonomic groups and for specific sound sources. As mentioned above, the US Marine Mammal Commission strongly urged setting the upper threshold for exposures up to the level treated by policymakers as unlikely to disturb. If disturbance is detected at levels below this, the series of playback experiments need not go higher, only document the level at which disturbance starts. However, the question remains what is the appropriate maximum level for playbacks,

assuming that there is no chance for physiological effects, or effects on hearing. For example, the High Energy Seismic Survey (HESS, 1999) suggests a threshold of potential impact for the sounds of airguns used in seismic exploration of 180 dB re 1 μ Pa, and subsequent environmental assessments of seismic survey in the Gulf of Mexico have not suggested a lower exposure threshold. Therefore in the setting of effects of seismic survey in the Gulf of Mexico, 180 dB is the maximum threshold for exposure under this application.

In other areas and for other sound sources, other thresholds may make sense. The SACLANT Undersea Research Centre of NATO has adopted a policy of not exposing marine mammals to received sound levels above 160 dB re 1 μ Pa (D'Amico, 1998). The assumption behind this policy is not only that exposure above the criterion level poses some risk, but also that there is a low risk for animals exposed below these thresholds. The proposed research can test this latter assumption. Thus for research in the Ligurian Sea where the SACLANT Centre operates, there is little need to test the reactions of animals to received levels above 160 dB re 1 μ Pa, since a primary operator of sound sources there has committed to a policy of not intentionally exposing animals to levels above this criterion. The Ligurian Sea also has been declared a whale sanctuary, and the ACCOBAMS treaty concerns pollution of material and energy in the Mediterranean. In this policy context, it is appropriate to test whether exposures to received levels up to 160 dB re 1 μ Pa may cause disturbance, but it may be inappropriate to expose animals to higher levels, depending upon regulatory actions taken by relevant nations, by the sanctuary, or by ACCOBAMS. If no disturbance is detected at received levels up to 160 dB, it may make sense to revisit the maximum exposure level for project 2, depending again upon the policy environment.

b) Minimizing disturbance

Our plan is to start playbacks of a specific signal to a focal animal at the lowest received levels thought to pose a risk of behavioral disruption. We will only increase the exposure after determining a low risk of disruption to the lower level. The design of these studies to test whether specific acoustic exposures cause behavioral disruption does not necessarily mean that we must continue increasing exposure until we detect disturbance. Few of these studies would be able to detect hearing effects such as temporary threshold shifts (TTS), so even if we have not detected behavioral disruption, we will limit exposure to levels below those thought to pose a risk of TTS. In addition, as discussed above, we plan to limit maximum exposure to within the range that is currently mitigated or treated as safe by regulatory agencies. The maximum exposure level we propose for our playbacks is a received level at the whale of 180 dB re 1 μ Pa rms for sounds of airguns and 160 dB re 1 μ Pa rms for other sounds. We plan playbacks to last on the order of 1-3 hours to test whether disrupted behavior may soon resume even during exposure, and we plan to follow post-exposure behavior carefully to monitor for how long it may take to return to baseline. In the past few years, we have increasingly succeeded with 12 hour tag attachments, a duration that allows for a 3 hour pre-exposure period, 3 hour exposure and up to 6 hours post exposure.

(1) Tagging

Selection of individual: Although it is necessary to approach close to the animal for a pole delivery, only a few minor reactions have been observed in tagging attempts with sperm and pilot whales during the last three years or research under permit no. 981-1578. Attempts to tag a particular individual will be terminated if 1) the animal shows an adverse reaction to the proximity or behavior of the tagging vessel; or 2) after the third close approach. Observers on the Tagging Vessel and, when possible, the OV, will record the animal's behavior during all approaches, tag attachment, as well as post-attachment. Using Weinrich *et al.*'s (1991) classification of responses to biopsy sampling, four potential levels of reaction may be documented: 1) no reaction (no detectable behavioral change); 2) low-level reaction (slight, mild behavioral change, e.g., flinch or fast dive, short duration); 3) moderate (forceful behavioral change, e.g. breach, short duration); 4) strong (succession of forceful activities). To mitigate potential disturbance, further tagging attempts on a particular individual will be discontinued if a moderate or strong reaction is observed to an attempt.

Selection of delphinid species: Since there are few leads as to which dolphins may be more sensitive to manmade noise, we propose opportunistic tag attachments, and we propose only to attach tags to animals that show minor reactions such as those reported in Hanson and Baird (1998). Hanson and Baird (1998) and Schneider *et al.* (1998) report dramatically different reactions to tagging of Dall's porpoise and bottlenose dolphins, with Dall's porpoise showing only the most minor reactions, and bottlenose dolphins off New Zealand showing profound disturbance reactions. We would not pursue tagging any animals showing disturbance reactions of the sort reported in Schneider *et al.* (1998).

(2) Playback

The primary feature we will control in our experiments is the received level of sound at the test subject, and we will model or measure sound propagation in order to predict and control exposure at the animal. The goal of the studies to test whether specific acoustic exposures cause behavioral disruption does not necessarily mean that we must continue increasing exposure until we detect disturbance. Few of these studies would be able to detect hearing effects such as temporary threshold shifts (TTS), so even if we have not detected behavioral disruption, we will limit exposure to levels below those thought to pose a risk of TTS or other risks to the auditory system. We propose a maximum received level of 180 dB re 1 μ Pa rms for sounds of airguns and 160 dB re 1 μ Pa rms for all other sounds, the level above which we will not expose animals. We will start each series of playback experiments with a particular species and stimulus type with a source level yielding a relatively low received level at the whale subject, e.g. 120 dB re 1 μ Pa rms. The source level will then be slowly increased over the series of a playback experiments up to a maximum received level of 160 dB re 1 μ Pa rms or 180 dB re 1 μ Pa rms for airgun sounds. If a response to playback is observed, we will stop increasing the goal received level, until this response has been well studied. Playbacks will be limited to total durations of about one-three hours, and animals will be followed after playback to monitor how long it takes them to return to baseline behavior. If any reaction is seen sufficient to cause concern about adverse physiological stress or any other risk, we will cease the sound transmissions for that playback experiment, and will communicate with the Office of Protected Resources of the NMFS.

c) Criteria to judge disturbance

Observers will carefully monitor for changes in behavior during playbacks. Visual observation of the movement patterns of animals with relatively short dive times can serve as a useful indicator of avoidance reactions or changes in surface/dive behavior during a playback. For animals such as sperm whales with potentially long dive times, passive acoustic tracking of vocalizing animals serves as a good criterion of disturbance. Disturbance of sperm whales can be judged during a dive if they cease vocalizing in response to a playback or if passive tracking indicates disturbance of normal dive behavior. After each playback, the primary criteria for disturbance from the acoustic stimuli will come from data from the DTAG. We will compare the pre-exposure baseline for each individual subject to the exposure condition using data on vocalizations, dive pattern, fluke strokes, orientation, and acceleration. The DTAG will provide more detailed data on possible disturbance reactions than has been possible for cetaceans in the past.

d) What will be done if evidence of disturbance is observed

During close approaches for tagging, some animals may show avoidance or other reactions. If an animal shows a strong attempt to avoid the approaching tagging vessel, or shows a moderate or strong reaction as judged by the Weinrich et al. (1991) classification, we will break off the approach and select a different subject. If after three approaches, we are not able to attach a tag, we will also select a different subject for tagging. The purpose of the playback experiments is both to detect disturbance reactions and to determine how exposure may affect the ability of exposed animals to achieve the goals of their activities. If we obtain evidence of a disturbance reaction during a playback, we will not increase the received level at the subject. We will continue to follow the focal animal and will monitor how long it takes the animal to return to baseline behavior. If there is any sign of prolonged responses that might pose a risk of physiological stress or risk of injury, we will stop the playback, and will communicate with the Office of Protected Resources of the NMFS. We would confer with NMFS OPR to develop a protocol to ensure that future playbacks would limit exposure to levels below those likely to expose animals to any such risk.

e) Acoustic Recording Tag

An acoustic recording tag offers a direct means to measure acoustic and motor behavior. By simultaneously recording the sound at the animal together with physiological and behavioral signals, the connection between sound and response or other behavior can be made directly. Specific advantages of an acoustic tag are:

1. The sound level at the animal (i.e., received level, RL) is measured directly. There is no reliance on transmission loss models alone to estimate RL.
2. There are no time alignment errors when correlating sound exposure and behavioral response.
3. It is possible (with the DTAG) to measure subtle and short-duration responses, e.g. fluke stroke frequency and amplitude, ensuring that almost any potential response will be documented.

An acoustic recording tag also provides information on the vocalization rate and types of vocalizations produced by individuals often of known age/sex/species. Acoustic recording tags have been demonstrated on elephant seals, dolphins, and right whales. The elephant seal tag used a hard drive to record low-bandwidth sound and pressure (Burgess *et al.*, 1998). A major discovery made with this tag was that the heartbeat of the host animal can be recorded acoustically, obtaining a response measure familiar from its wide use on terrestrial species. This result has been duplicated using the Dtag with dolphins, and demonstrated heart rate responses to noise (Miksis *et al.* 2001).

6. NEPA Considerations

NMFS permit 981-1578 was the subject of a lawsuit, Hawaii County Green Party v.s Evans, No. C-03-0078-SC (ND Calif.). The Court ruled that the environmental review by NMFS was insufficient for NMFS permit 981-1578. Therefore, the applicant requests that NMFS conduct an appropriate environmental review on this application for a new permit.

a) The research involves new, innovative, controversial, or experimental equipment or techniques

The initial application for permit no. 981-1578 in 2000 did involve new and innovative equipment in the Dtag, but by this time, it has been well tested and is no longer so novel. I do not consider the playbacks or controlled exposure experiments to be particularly new, nor are they controversial among experts in biology and acoustics. However, the judge in this suit ruled that acoustic research in general is controversial.

b) The research techniques are likely to be adopted by other researchers

The WHOI research team that has developed the Dtag is collaborating with other groups in the permitted research, but have no plans to sell the tag to other researchers. The controlled exposure experiments of the scale proposed here are unlikely to be adopted by many groups – few marine mammal research projects are conducted at the scale of the controlled exposures covered by this permit.

c) The location in which the research will be conducted is of special importance to other marine mammals

The locations of the controlled exposures in the Mediterranean take advantage of the species occurring there, so the only marine mammals other than those potentially being studied are *Kogia* and beaked whales of the genera *Ziphius* and *Mesoplodon*. No playbacks will occur near the *Ziphius* habitat that has been identified in the Ligurian Sea, but animals will be tagged there to study baseline behavior. Some of the research in the Mediterranean will take place in the Ligurian Sea Whale Sanctuary, which has been jointly declared by France, Italy, and Monaco. An upwelling develops in this area in the summertime, providing prey for whales and dolphins, and leading to higher sighting rates than many other areas of the Mediterranean. This makes it a good study site for any of these species for the permitted research.

The locations of the controlled exposures to sperm whales in the Gulf of Mexico involve areas where other species of odontocete are relatively frequently sighted and

where Bryde's whale and perhaps another mysticete may rarely be sighted, but the areas are not known to be of special importance to these other species.

d) The proposed activities involve unique or unknown risks or whether the likely effects are highly uncertain.

The close approaches, non-invasive tag attachment, and focal follows are well-tested techniques with no unique or unknown risks. The playbacks or controlled exposure experiments involve sound sources that are very common. For example, we propose about 20 playback experiments per year in the Gulf of Mexico. If the source vessel starts about 10 km from the tagged whales, and passes 5 km beyond, each playback will involve 15 km of transmission and the 20 playbacks will involve no more than 200 miles of transmissions. By contrast, the oil industry ran 213,000 miles of transmissions from airgun arrays in 2002 (data courtesy of Minerals Management Service). Similarly, there are thousands of sound sources similar to the whalefinding sonar to be tested in the Ligurian Sea. For example, depth sounding and bottom profiling sonars often operate in the 1-12 kHz frequency band with source levels similar to the whalefinding sonar. For example, Table 6.8 in Richardson et al. (1995) lists bottom profilers as operating in the 0.4-30 kHz band, with pulse durations of 0.1-160 msec and source levels of 200-230 dB. Most ships operate depth sounding sonars all of the time at sea, and bottom profilers are a common research tool. Adverse impacts have not been observed from these sources, but there have been few studies looking in detail at exactly how marine mammals respond to them during their dives.

The proposed research is carefully designed to test for behavioral responses to these sounds while minimizing the risk of disturbance.

One area of growing concern regarding the effects of sound on marine mammals concerns correlations of unusual mass strandings of beaked whales, especially *Ziphius*, but also including several species of *Mesoplodon*, with naval maneuvers (e.g., Simmonds and Lopez-Jurado, 1991; Frantzis, 1998). As far as is known, several of these mass strandings were associated with naval maneuvers involving powerful military sonars operating at source levels of 230+ dB re 1 μ Pa rms in the 2.5-8 kHz region (Evans and England 2001). The geometry of the sonar transmissions and the strandings indicates that the whales were almost certainly within several tens of kilometers of the sonars when exposed to their sounds. The sound propagation present in those sites suggests that the whales were exposed to received levels above 160 dB re 1 μ Pa rms, and that this exposure could have continued for hours. The whalefinding sonar to be tested here operates at frequencies including several within the same mid-frequency band. However, with a source level of 210 dB re 1 μ Pa rms, less than 1/100 the level of the military sonars, exposure above 160 dB re 1 μ Pa rms would be limited to 317 meters. The source will be slowly ramped up from a source level of 160 dB re 1 μ Pa rms at 1 m. This affords any animals within a few hundred meters of the moving source the opportunity to swim away and avoid exposure to levels above 160 dB. Visual observers will monitor for animals within this 160 dB re 1 μ Pa rms range for half an hour before transmissions start, and the source will not be started, or if started will be shut down if any animals are sighted that could potentially come within this 160 dB re 1 μ Pa rms range. With the ship moving at 5 knots (8 km/hr), even if an animal were not sighted, showed no avoidance,

and were directly in its path, the longest exposure an animal would have above 160 dB would be less than 5 min. Because of the apparent special sensitivity of these species, even though the whalefinding sonar operates at a maximum power 1/100 of the military sonars, and will be conducted with extensive mitigation procedures, research with the whalefinding sonar in the Ligurian Sea will not be conducted in areas where Cuvier's beaked whales are sighted. Extensive survey efforts in this area show that Cuvier's beaked whales tend to be sighted in predictable areas in the northern Ligurian Sea (Figure 1).

Malakoff (2002) reports on a stranding of two *Ziphius* in the Gulf of California near seismic operations, but this stranding is quite different from the pattern seen in the mass strandings correlated with military sonar and a link has not established between the sounds from the seismic survey and the strandings. No other similar stranding has been correlated with any of the millions of miles of seismic surveys conducted by industry in the last few years.

These kinds of observations indicate the need for caution in use of any high-intensity pulsed sound, and the research conducted under this permit involves safeguards in recognition of this need for caution. Given the current state of knowledge about this problem, and given the safeguards, the beaked whale data do not indicate any unique or unknown risks from the activity to be conducted under this permit.

e) Any aspect of the research possibly affects the public health or safety of humans

Not applicable.

f) The activity may have a significant cumulative effect, considering existing and potential activities

As discussed above in section D6d, the proposed research involving playbacks will have a tiny effect compared to the existing sound sources, which are usually operated with little regulation concerning possible effects on marine mammals. The research to be conducted under this permit is specifically designed to test for minor behavioral effects of exposure to these sounds, and these data will be used to establish regulations to protect marine mammals from adverse impacts of noise. Therefore, the activity will have a barely measurable cumulative impact in the short term, and is likely in the long term to reduce any adverse impacts of noise from the more common sources.

g) The activity causes loss or destruction of significant scientific, cultural, or historic resources

Not applicable. The activity will cause no loss or destruction of any scientific, cultural, or historic resources. Denial of the activity would cause the loss of significant scientific resources. The research proposed here involves the commitment of millions of dollars of scarce public funds for research support.

h) There will be an adverse effect on endangered or threatened populations or stocks or their habitat

No adverse effect is anticipated. The proposed sound transmissions will not harm either marine mammals or the populations of prey species upon which they depend. Of the

species preyed upon by marine mammals, fish are thought to be the most sensitive to airguns, because of their air-filled swim bladders. The seismic industry switched from using explosives to airguns as a sound source in part because airguns do not kill fish. McCauley et al. (2000a,b, 2002) and Popper et al. (2002) review recent data that injurious effects on fish, especially on fish hearing, may occur to somewhat greater distances than previously thought, but these will still be limited to short distances from the airguns, and reduced by avoidance reactions of fish near airguns. Exposure to levels from airgun impulses of 180 dB re 1 μ Pa in the 20-100 Hz band can damage the hair cells of the inner ear in at least one species of fish (McCauley et al. 2000a, 2003). Fish near airguns may show behavioral responses that might reduce the ability of cetaceans to feed near the source (Engås and Løkkeborg 2002). But the source only ensonifies a small part of the habitat, the fish habituate to the sound, and cease responding when the source is turned off, so this reaction to the brief exposures in the proposed experiments would not adversely affect feeding by marine mammals.

Endangered sea turtles are present in both the Mediterranean and the Gulf of Mexico where playback experiments are planned. Sea turtles have well-developed ears, and several studies suggest that they can hear sounds below 1 kHz, but no evidence suggests that they can hear higher frequencies. Studies of hearing in juvenile loggerhead sea turtles suggest that they can hear frequencies between 250-750 Hz, with best hearing at 250 Hz (Bartol et al., 1999). Green turtles are most sensitive to frequencies of 300-400 Hz, but their sensitivity declines rapidly outside of this range (Ridgway et al., 1969). The great majority of energy from airguns is outside of this frequency range of sea turtle hearing. However, airgun impulses are intense enough and broadband enough that sea turtles certainly can hear them. All of the energy from the whalefinding sonar to be tested in the Ligurian Sea is far enough above the hearing of sea turtles, that it is less likely that these signals can be heard or would have adverse effects on sea turtles.

There are no published reports of effects of airguns on sea turtles at sea. However, several studies have reported responses of sea turtles held in enclosures to pulses from single airguns. McCauley et al. (2000b) report that a green and loggerhead turtle showed responses that would probably reflect an avoidance response in unrestrained turtles at received levels of 166 dB re 1 μ Pa rms. O'Hara and Wilcox (1990) studied responses of 9 loggerhead turtles to an airgun plus two small sources called "poppers." They did not measure received levels at the turtles, but did avoid a range of about 30 m, which McCauley et al. (2000b) estimate to reflect a received level of about 175 dB re 1 μ Pa rms. Moein et al. (1994) studied responses of ten loggerhead turtles to a single airgun, and observed avoidance responses at received levels of 175 – 179 dB re 1 μ Pa, but did not specify whether these measurements were rms, 0-peak, or peak-peak. McCauley et al. (2000b) summarize these three studies by suggesting that the behavior of sea turtles may alter at ranges of 2 km corresponding to a received level of 166 dB re 1 μ Pa and are likely to avoid ranges of 1 km corresponding to received levels of 175 dB re 1 μ Pa. Moein et al. (1994) retested some of the same turtles several days after the first exposure. While they referred to this as the behavioral effect called habituation, it is possible that the exposure reduced their hearing sensitivity. Such an effect would be unlikely to occur in free ranging sea turtles if they showed the avoidance response predicted by McCauley et al. (2000b). Therefore, no adverse effects are anticipated. However, to be especially cautious with these endangered species, if our visual observers

sight a sea turtle that might come within the maximum exposure region, the source will be shutdown.

i) The activity is in violation of a Federal, State, or local law for environmental protection.

This activity is not in violation of any laws for environmental protection, and has the potential to gather data critical for developing regulation to protect marine mammals from adverse impacts of manmade noise.

E. Publication of Results

The research results will be published in peer-reviewed scientific journals such as the Journal of the Acoustical Society of America, Behavioral Ecology and Sociobiology, IEEE Journal of Oceanic Engineering, and Animal Behavior. The results will also be presented at the earliest possible opportunities at scientific conferences such as the Acoustical Society of America, the European Cetacean Society, and the Society for Marine Mammalogy.

F. Proposal and Previous and Other Permits

1. Copies of formal research proposal(s)

One of the research projects covered under project 1 of this permit application involves a collaborative research project with the Northeast Fisheries Science Center and WHOI for tagging whales in the North Atlantic slope waters of the eastern US. The WHOI involvement in this project was funded by a proposal to the US Minerals Management Service. Other baseline tagging under project 1 may be covered by funding from the Packard Foundation and the SERDP program. This application for a permit includes as part of project 2 a collaborative project with the Saclant Undersea Research Centre. The WHOI involvement in this project was funded by a proposal to the U.S. Office of Naval Research. This application for a permit includes as part of project 3 a collaborative project with a large number of participants, including Ecologic Inc, the International Association of Geophysical Contractors, Lamont-Doherty Earth Observatory, US Minerals Management Service, US National Science Foundation, UK Sea Mammal Research Unit, and Texas A&M University. The WHOI involvement in this project was funded as a subcontract to the Texas A&M University. Copies of these research proposals will be sent to the NMFS Permit Office under separate cover.

2. Sponsors and Cooperating Institutions

Sponsors

The David and Lucile Packard Foundation
300 Second Street
Los Altos, California 94022

Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, L. A. 70123-2394
(504)-736-2595

National Marine Fisheries Service
NOAA Fisheries, 1315 East West Highway, SSMC3,
Silver Spring, MD 20910

National Science Foundation
4201 Wilson Boulevard,
Arlington, Virginia 22230, USA
Tel: 703-292-5111

Office of Naval Research
Ballston Centre Tower One
800 North Quincy Street
Arlington, VA 22217-5660
Phone: 703-696-5031
Fax: 703-696-5940

Strategic Environmental Research and Development Program
901 North Stuart Street, Suite 303
Arlington, VA 22203
Phone: (703) 696-2117
Fax: (703) 696-2114

Cooperating Institutions

Lamont Doherty Earth Observatory, Columbia University
P.O. Box 1000
61 Route 9W
Palisades, NY 10964-1000 USA

Northeast Fisheries Science Center
166 Water Street
Woods Hole, Massachusetts 02543

Saclant Undersea Research Center
Viale San Bartolomeo 400
19138 La Spezia Italy

Sea Mammal Research Unit
Gatty Marine Laboratory
University of St Andrews
St Andrews
Fife KY16 8LB
Tel: (011 44)1334 462630
Fax: (011 44)1334 462632

Texas A&M University

Department of Oceanography, College of Geosciences,
Texas A&M University
3146 TAMU, College Station, TX 77843-3146
Phone: (979) 845-7211
Fax: (979) 845-6331

3. Previous permits

Tyack conducted tagging and playback experiments with sperm whales in collaboration with William A. Watkins under permit no. 765, which ended as of 31 December 1997. The SURTASS LFA playback experiments were conducted under NMFS permit no. 875-1401. These experiments also involved similar protocols limiting exposure of animals to received levels below 160 dB re 1 μ Pa. The final report for the permit was submitted on August 12, 1999. Tyack's group also tagged sperm whales in the Gulf of Mexico during the spring and summer of 2001 under permit no. 369-1440-01 issued to Bruce Mate and during summer of 2001 under permit no. 917 issued to the NMFS Northeast Fisheries Science Center, Richard Merrick, Principal Investigator. Research similar to that covered by this permit was included in permit no. 981-1578, as amended. As noted above, permit no. 981-578 was the subject of Hawaii County Green Party v. Evans, No. C-03-0078-SC (USDC ND Calif.), in which an injunction was issued. Permit no. 981-578 will be returned with a final report once the permit requested in this application is approved.

4. Other Federal and State Permits

Some of this research will also take place in the territorial seas of other nations. We will apply for the appropriate permits from the controlling authorities for this research. Any import/export of tissue from CITES species will occur with CITES permit.

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V. Special Considerations for Applicants Working Abroad

Not applicable

VI. Certification and Signature:

I hereby certify that the foregoing information is complete, true, and correct to the best of my knowledge and belief. I understand that this information is submitted for the purpose of obtaining a permit under one or more of the following statutes and the regulations promulgated thereunder, as indicated in Section I. of this application:

The Endangered Species Act of 1973 (16 U.S.C. 1531-1543) and regulations (50 CFR 222.23(b)); and/or

The Marine Mammal Protection Act of 1972 (16 U.S.C. 1361-1407) and regulations (50 CFR Part 216); and/or

I also understand that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or to penalties provided under the Endangered Species Act of 1973, the Marine Mammal Protection Act of 1972, or the Fur Seal Act of 1966, whichever are applicable."

Signature: _____ Date: 8 March 2003

Peter L. Tyack
Senior Scientist
Biology Department
Woods Hole Oceanographic Institution

Appendix 1

PROCEDURE FOR CALCULATING ANNUAL NUMBER OF EACH KIND OF TAKE FOR EACH PROJECT AND EACH SPECIES

Project I: Tagging to observe baseline behavior (no playback)										
Letters for Columns below correspond to letters for Table 6, and are discussed below										
A	B		C			E	F	G	H	I
Species	Goal for # animals success fully tagged annually	Estimated tagging success rate (# successes/ touch)	Max annual # tagging takes (B/C)	Est approach success rate (# close approaches/tag touch)	Est # animals in close approach	Max Annual # close approach takes (tagged indiv + incidental) (DxF/E)	Max Annual # focal follow takes (tagged indiv + incidental) (DxF)	Goal # playbacks directed to species per year	Max annual # of playback takes (directed + incidental)	Location
Humpback whale (<i>Megaptera novaeangliae</i>)	20	0.67	30	0.67	3	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Minke whale (<i>Balaenoptera acutorostrata</i>)	20	0.67	30	0.67	3	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Bryde's whale (<i>Balaenoptera edeni</i>)	20	0.67	30	0.67	3	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Sei whale (<i>Balaenoptera borealis</i>)	20	0.67	30	0.67	3	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Fin whale (<i>Balaenoptera physalus</i>)	20	0.67	30	0.67	3	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Blue whale (<i>Balaenoptera musculus</i>)	20	0.67	30	0.67	3	135	90	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Sperm whale (<i>Physeter macrocephalus</i>)	40	0.4	100	0.33	3	900	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Beaked whales (<i>Mesoplodon</i> sp.)	20	0.2	100	0.25	3	1200	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	20	0.2	100	0.25	3	1200	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Bottlenose whale (<i>Hyperoodon ampullatus</i>)	20	0.2	100	0.25	3	1200	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Pilot whales (<i>Globicephala</i> sp.)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Bottlenose dolphin (excluding mid-Atlantic coastal stock) (<i>Tursiops truncatus</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Common dolphin (<i>Delphinus delphis</i> and possibly <i>D. capensis</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Atlantic spotted dolphin (<i>Stenella frontalis</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)

Pantropical spotted dolphin (<i>Stenella attenuata</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Striped dolphin (<i>Stenella coeruleoalba</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Spinner dolphin (<i>Stenella longirostris</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Clymene dolphin (<i>Stenella clymene</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Rough-toothed dolphin (<i>Steno bredanensis</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Fraser's dolphin (<i>Lagenodelphis hosei</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Kogia spp. (<i>K. simus</i> and <i>K. breviceps</i>)	20	0.2	100	0.25	3	1200	300	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Risso's dolphin (<i>Grampus griseus</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Killer whale (<i>Orcinus orca</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
False Killer whale (<i>Pseudorca crassidens</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Melon-headed whale (<i>Peponocephala electra</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)
Pygmy killer whale (<i>Feresa attenuata</i>)	20	0.2	100	0.5	10	2000	1000	N/A	N/A	North Atlantic (including Med and Gulf of Mexico)

Project II: Tagging combined with whalefinding sonar experiment and sperm whale coda playbacks

Letters for Columns below correspond to letters for Table 6, and are discussed below

A	B		C			E	F	G	H	I
Species	Goal for # animals success fully tagged annually	Estimated tagging success rate (# successes/ touch)	Max annual # tagging takes (B/C)	Est approach success rate (# close approaches/ tag touch)	Estimated # animals in close approach	Max Annual # close approach takes (tagged indiv + incidental) (DxF/E)	Max Annual # focal follow takes (tagged indiv + incidental) (DxF)	Goal # playbacks directed to species per year	Max annual # of playback takes (directed + incidental)	Location
Minke whale (<i>Balaenoptera acutorostrata</i>)	20	0.67	30.00	0.67	3	135	90	20	400	Mediterranean
Fin whale (<i>Balaenoptera physalus</i>)	20	0.67	30.00	0.67	3	135	90	20	400	Mediterranean
Sperm whale (<i>Physeter macrocephalus</i>)	20	0.4	50	0.33	3	450	150	20	400	Mediterranean
Beaked whales (<i>Mesoplodon</i> sp.)	N/A	N/A	0	N/A	N/A	0	0	0	400 incidental	Mediterranean
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	N/A	N/A	0	N/A	N/A	0	0	0	200 incidental	Mediterranean

Pilot whales (<i>Globicephala</i> sp.)	20	0.2	100	0.5	10	2000	1000	20	2000	Mediterranean
Bottlenose dolphin (<i>Tursiops truncatus</i>)	20	0.2	100	0.5	10	2000	1000	20	2000	Mediterranean
Striped dolphin (<i>Stenella coeruleoalba</i>)	20	0.2	100	0.5	10	2000	1000	20	2000	Mediterranean
Common dolphin (<i>Delphinus delphis</i> and possibly <i>D. capensis</i>)	20	0.2	100	0.5	10	2000	1000	20	2000	Mediterranean
Rough-toothed dolphin (<i>Steno bredanensis</i>)	20	0.2	100	0.5	10	2000	1000	20	2000	Mediterranean
Kogia spp. (<i>K. simus</i> and <i>K. breviceps</i>)	N/A	N/A	0	N/A	N/A	0	0	0	400 incidental	Mediterranean
Risso's dolphin (<i>Grampus griseus</i>)	20	0.2	100	0.5	10	2000	1000	20	2000	Mediterranean
Killer whale (<i>Orcinus orca</i>)	20	0.2	100	0.5	10	2000	1000	20	2000	Mediterranean
False Killer whale (<i>Pseudorca crassidens</i>)	20	0.2	100	0.5	10	2000	1000	20	2000	Mediterranean

Project III: Tagging combined with airgun and/or sperm whale coda playbacks										
Letters for Columns below correspond to letters for Table 6, and are discussed below										
A	B		C			E	F	G	H	I
Species	Goal for # animals success fully tagged annually	Estimated tagging success rate (# successes/ touch)	Max annual # tagging takes (B/C)	Est approach success rate (# close approaches/ tag touch)	Estimated # animals in close approach	Max Annual # close approach takes (tagged indiv + incidental) (DxF/E)	Max Annual # focal follow takes (tagged indiv + incidental) (DxF)	Goal # playbacks directed to species per year	Max annual # of playback takes (directed + incidental)	Location
Humpback whale (<i>Megaptera novaeangliae</i>)	N/A	N/A	0	0	N/A	0	0	0	12 incidental	Gulf of Mexico
Minke whale (<i>Balaenoptera acutorostrata</i>)	N/A	N/A	0	0	N/A	0	0	0	2 incidental	Gulf of Mexico
Bryde's whale (<i>Balaenoptera edeni</i>)	N/A	N/A	0	0	N/A	0	0	0	12 incidental	Gulf of Mexico
Sei whale (<i>Balaenoptera borealis</i>)	N/A	N/A	0	0	N/A	0	0	0	2 incidental	Gulf of Mexico
Fin whale (<i>Balaenoptera physalus</i>)	N/A	N/A	0	0	N/A	0	0	0	2 incidental	Gulf of Mexico
Blue whale (<i>Balaenoptera musculus</i>)	N/A	N/A	0	0	N/A	0	0	0	2 incidental	Gulf of Mexico
Sperm whale (<i>Physeter macrocephalus</i>)	40	0.4	100	0.33	3	900	300	20	400	Gulf of Mexico
Beaked whales (<i>Mesoplodon</i> sp.)	N/A	N/A	0	0	N/A	0	0	0	400 incidental	Gulf of Mexico

Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	N/A	N/A	0	0	N/A	0	0	0	200 incidental	Gulf of Mexico
Pilot whales (<i>Globicephala</i> sp.)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Bottlenose dolphin (<i>Tursiops truncatus</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Common dolphin (<i>Delphinus delphis</i> and possibly <i>D. capensis</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Atlantic spotted dolphin (<i>Stenella frontalis</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Pantropical spotted dolphin (<i>Stenella attenuata</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Striped dolphin (<i>Stenella coeruleoalba</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Spinner dolphin (<i>Stenella longirostris</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Clymene dolphin (<i>Stenella clymene</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Rough-toothed dolphin (<i>Steno bredanensis</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Fraser's dolphin (<i>Lagenodelphis hosei</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
<i>Kogia</i> spp. (<i>K. simus</i> and <i>K. breviceps</i>)	N/A	N/A	0	0	N/A	0	0	0	400 incidental	Gulf of Mexico
Risso's dolphin (<i>Grampus griseus</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Killer whale (<i>Orcinus orca</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
False Killer whale (<i>Pseudorca crassidens</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Melon-headed whale (<i>Peponocephala electra</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico
Pygmy killer whale (<i>Feresa attenuata</i>)	N/A	N/A	0	0	N/A	0	0	0	2000 incidental	Gulf of Mexico

Explanation of columns

Column B: Goal for # animals successfully tagged: This is the maximum number of individuals of the species we would want to tag in a year. The text just after table 9 describes in detail how these goals were set for each project. These tables show how the annual numbers were calculated for each of the three projects covered under this permit application.

Column C: Max Annual Number of Tagging Takes: This number is larger than the tagging goal in column B because not every tagging take yields the data we need for a successful tagging. The NMFS Permit Office counts as a tagging take every time any part of the tag touches a whale. The probability that a tag will stay on the whale once it has touched depends upon the species, and the duration of attachment that we need for success depends upon the project as well. Table 10 shows how the Maximum Annual Number of Tagging Takes is calculated from this information.

Column D: Repeat Takes: Used in Table 6 but not in this Appendix

Column E: Maximum Annual Number of Close Approach Takes: This number is larger than the Maximum Annual Number of Tagging Takes because some close approaches are required for photo-identification etc, and because the tagging team is not able to touch a tag to the whale on every approach. Sometimes the whale may dive or move away. If the tagging team feels that the whale is showing any negative reaction to the approach, they also stop the approach. The probability that a close approach will lead to the tag touching the whale depends upon the species. In addition, in most species, an animal selected for tagging may surface close enough to other individuals that a close approach to the selected animal requires the tagging vessel to also approach relatively closely to these other individuals. This number of close companions also varies by species. These close companions are also counted as incidental close approaches. Table 10 shows how the Maximum Annual Number of Close Approaches required for tagging is calculated from this information. At each stage we make conservative estimates that lead our estimated number takes to be higher than we are actually likely to find in the field. This estimate is not an estimate of expected harassment. Following advice from the NMFS Permit Office, we count and report every close approach because it represents a situation with a potential for harassment. It is not common for a close approach of animals not selected for tagging to result in any behavioral responses, especially for the animals such as delphinids, where the number of close companions is potentially large enough for the maximum number of close approaches to be large.

Column F: Max Annual Number of Focal Follow Takes: Focal follow refers to our protocol of following an individual whale from a vessel. It is sometimes possible to follow an individual using natural markings, but most of the focal follows under the permitted research involve following the tagged whale until the tag falls off. We often try to follow a focal whale selected for tagging before and after the tag falls off as well. Our goal in these follows is for the observation vessel(s) not to affect the behavior of the whales at all. Since the tag gathers detailed behavioral data and gives a radio signal whenever the tagged whale surfaces, we can follow the whale at greater ranges than those required for close visual observations without the tag. The way we calculate the maximum annual number of animals involved in focal follow involves multiplying the number of tagging takes by the estimated number of animals likely to be found with the tagged individual. We use the same number of animals near the focal as is estimated for the close approaches. Our goal is to have no animals harassed by the focal follow, and we have seldom detected any responses at all. However, we count and report every animal

involved in the focal follows because it represents a situation with a potential for harassment. Given the expectation that few, if any, animals will be harassed by focal follow, the estimated numbers may seem unreasonably high. However, this overestimation makes the environmental analyses of the permitted research particularly conservative. In addition, one of the goals of these studies is to detect and report any disruption of behavior. The conservative process for estimating large numbers of potential takes ensures that even the most subtle behavioral changes, potentially discovered well after the field work, would be covered by this permit. Note that the same whale may be counted once as a close approach, tagging, and focal follow take. Thus it is incorrect to add up all the takes as if that represented the number of animals taken.

Column G: Goal Number of Playbacks: The annual goal number of playbacks is determined by a combination of the total number of experiments needed for a whole series of playbacks, and of the way in which playbacks are staged in sets of increasing exposure. The planned length and number of cruises per year also affects the annual goals. We plan a specific series of experiments that focus on sperm whales. This leads to a higher sample size for this species – up to 40 / year. For most other species, we propose a maximum annual number of 20 playbacks. There is no chance that the number of playbacks we actually perform will be anywhere close to the total requested across all species. During cruises in the Mediterranean for project 2, we will focus particularly on sperm whales, but it will be very useful to study other species in the area. It is difficult to predict which species will be most available, so in order to take advantage of opportunities in the field, we request for each the total tagging opportunities per cruise. This also covers for potential incidental takes during playbacks to other species in the Mediterranean.

Column H: Maximum Annual Number of Playback Takes: The maximum number of playback takes is larger than the goal number of playback experiments for two reasons. Some animals may be incidentally exposed to playbacks in the course of an experiment directed at another species. In addition, most of the species covered by this application are social. Any playback directed at one or a few members of a group are likely to lead other members of the group to be exposed as well. In the Gulf of Mexico, we have found that we can simultaneously tag several sperm whales and one playback to these animals yields more than one playback subject per playback experiment. Since sound travels well underwater, more animals could potentially be affected by playback than by the close approaches for tagging. Therefore the group size used to estimate playback takes (shown in Table 11) is larger than the size used to estimate close approach takes.